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A RECONNAISSANCE SOIL SURVEY OF A PORTION  
OF KWANGTUNG PROVINCE //

by  
Robert L. Pendleton



SUMMARY

This report is the result of field notes, written and photographic, relating to the soils of a considerable portion of Kwangtung Province. These observations were ~~observations were~~ collected in the course of a study of the ways and means of improving the quantity and quality of agricultural and forest products of the province. The observations of a more specifically agricultural nature are included in a separate report.

As the region covered is about 650 kilometers by 300 kilometers in its longest dimensions, and the geological, and topographical conditions being so diverse, in addition to the climatic variations, the variety of soil-forming processes and conditions and resulting kinds of soils are extremely numerous.

Rainfall and temperature data for the province are summarized.

The data are presented mainly in the form of route notes, the routes followed being shown on Map..., the numerals indicating the pages of the report where the descriptions are found, and the Figure numbers of views illustrating features of the locality.

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Three new series of soils have been established:  
Chumen--reddish brown mature soils residual from basalt;  
Pakhoi--brown to reddish brown deeply weathered senile  
lixivium soils from unconsolidated sedimentary deposits;  
Lankong series-black soils high in organic matter,  
overlying a white sub-soil, in depressions in the Pakhoi  
series.

Supplementary notes are included relating to the Canton, Lokong, Chungtsun, Shiuping, Chukiang, Kiangtsun, Shihpai, Lungyen-tung, and Fuling series, in the Pan-Yu district, Canton, as mapped and classified by Tang.

Descriptions are given of the very general preparation of fertilizer composts, with pond mud as a constituent, and particularly the special use of marine mud at Pakhoi, in combination with waste organic matter.

The extensive and heavy use of lime on rice fields on older soils, and the incorporation of straw into some of the rice soils during crop growth are interesting features of local soil management practices.

The soil map accompanying the report shows in general only the broad separations, the exceptions being the Chumen, Pakhoi, and Kochou series.

Mature soils are relatively infrequent. Those that have been observed indicate that the best designation for this soil region is the "Sub-Tropical Lixivium Region."



## INTRODUCTION

The purpose of this soil survey was to obtain as much information as possible regarding the soils of Kwangtung province, particularly those soils at present uncultivated or otherwise producing relatively little. The main observations relating to the possibilities of agricultural development especially of idle lands, the directions that such development might take and the scientific work necessary as a firm foundation for such development, have been discussed in a separate report, "A Study of Certain Factors Relating to the Improvement of Agriculture and Forestry in Kwangtung Province." already submitted to the Director of Agriculture and Forestry, Kwangtung Province.

Due to the large amount of territory which an effort was made to cover, both independently and with a large party of specialists, the observations as recorded here have been perforce at times of a very general nature; while at other times, as near Canton and in the extreme southwest, relatively much more attention was given to some of the soil groups and conditions. Necessarily, therefore, the information is rather uneven as to the relative amount of data on different soil groups and conditions. Of some of the soil groups there has been obtained enough information to give quite full descriptions of important soil groups and to propose new soil series names while in other cases it is possible to give



little more than running notes of observations made while travelling by railway, road, or trail.

The writer had previously been requested to study the soils of Kwangtung, and to in any way possible cooperate with or assist those in the Province engaged in the study of the soils. It was while engaged in familiarizing himself with the soils already surveyed, and other important soils, and the methods of soil research, that the Bureau of Reconstruction and its Department of Agriculture and Forestry, Kwangtung Province thru obtaining permission for his services and appointing him to a special commission for the study of the development of the Province, made it possible for the writer to travel so extensively in the province. The faculties of the Colleges of Agriculture, Sun Yatsen University and Lingnan University deserve thanks for the facilities made available and assistance rendered in these soils studies. Especial thanks are due to Professor C. Y. Pan for his painstaking efforts in acting as interpreter, and in assisting in the many other details of travel and study.

#### DESCRIPTION OF THE REGION

The region studied comprises roughly the main agricultural districts along the three main rivers, the North River, to beyond Shiuchou, the West River to Namkonghou, the East River to beyond Waichou, and in places along the coast between Bias Bay on the east, and Pakhoi on the west,

and Hoihow, Hainan on the south, i.e. between  $20^{\circ}$  and  $26^{\circ}$  North Latitude, and  $109^{\circ}$  and  $115^{\circ}$  East Longitude. In other words, this survey extends over a maximum direct distance from northeast to southwest of 650 kilometers (400 miles) and to as far inland as 300 kilometers (185 miles) from the main coast line.

The general topographic features of the region are best shown by the accompanying layered topographic map. Many of the smaller hills and other topographic features are not shown. Both Fenzel and Chang report about 90% of the total area to be of hilly land that is unfit for agricultural use. Physiographically the main Canton region is one of a drowned topography with the lower or higher hills many times rising abruptly from the recent alluvial plains. From Muiluk to Pakhoi there has been more likely an elevation of the coast line, raising above the sea the at present vast expanses of uplands composed of relatively unconsolidated shallow water deposits. Both on the Luichou peninsula and on Hainan Island there have been some geologically recent volcanic eruptions with basaltic effusions now more or less deeply weathered to soils.

The extreme differences in elevation are not very great. From the delta lands at or just above sea level, to the highest mountain peaks in the north of the province, there is a range of only a little over 1500 meters.

The geology of the region appears to be very complicated, and this is confirmed by the manuscript geologic



map of the region. As this map also indicates, there yet remains a great deal to be done on the geology, before it is well understood. To make the study more difficult, the very deep weathering of the rocks, particularly in the coastal regions of higher temperature and greater rainfall, has greatly altered the original nature of the rocks and formations. And where the natural cover has been destroyed, by the pressure of population, as near Kowloon and about Canton, the erosion of these deeply weathered materials is very serious.

The regional drainage is exceedingly complicated, as may be seen from the topographic map. The three main rivers, North, West, and East, drain an extensive region. Along the coast there are a number of shorter streams flowing out more directly to the sea.

The population is made up of a number of diverse components. There were the pre-Chinese tribes, interesting to us because their tradition of forestry still persists in some of the isolated mountains districts. There are the Hakkas in the central and northern portion of the region, while the Cantonese occupy the main portion of the central delta. In the Luichou peninsula are groups who had immigrated from Swatow and elsewhere northeastward. The colonies of European nations within the region under study are: Hong Kong, British; Macao, Portuguese; and Kwangchouwan, French.



The transportations systems are varied, but as yet inadequate to serve the needs of the region, particularly in the outlying portions. On the rivers, sea, and estuaries are many sorts of local craft towed or propelled by hand, foot, wind, oil or steam power carrying an extensive commerce. The railways from Canton to Kowloon, Canton to Shiuchou, and Canton to Samshui provide facilities for freight and passenger traffic. At present the Shiuchou line is being extended toward Hankow, a very much needed railway. The highway system is being rapidly extended, to meet a very great need for more rapid transportation for passengers, freight, and troops. When completed the highway system will be an extremely important one. At present the highways are divided between company monopolies and public roads; the company roads generally being of distinctly higher class.

The principal centers of commerce are Canton and Hong Kong. Pakhoi and Hoihow are less important commercial centers.

NATURE OF THE REPORT AND THE SOIL MAP

The amount of information that was obtained, and the detail on the soil map are both very general in nature; due to the following limitations: (1) The field work was done in the rainy season, with the rice soils, the most important group in the region, all flooded. Samples of even upland soils were even often difficult or impossible to obtain. (2) Due to the poor roads, or their absence, and to the crowded and frequently bad condition of the busses or trucks, there were severe limitations upon transportation of baggage, samples, and other field equipment. (3) Because of the great distances to be covered, and the delays from time to time, and the large party travelling together part of the time, long distances had to be covered without possibility of making en route a desirable number of examinations of the soil or other conditions. (4) In addition to the above difficulty, due to the absence of suitable base maps for use in the field, it was impossible to carry on even the most ordinary field plotting of soil groups. (5) More than the usual language difficulties and differences from locality to locality, made it more difficult than usual to obtain the information that was desired, even when there was the time and the opportunity to do this.

Circumscribed by the above limitations and considerations, the results of the field work necessarily have assumed the following forms: (1) Intensive observations of local conditions, with note book records. (2) Nearly a thousand photographs were taken of soil and agricultural conditions, as being the best possible supplement to the other observations. (3) A few soil samples were obtained, but entirely inadequate to properly represent the conditions of the region.

Therefore this survey is merely an orientation survey, to serve as a basis for adequate study of the conditions found to exist in the region. This report is mainly confined to the soils, the agricultural conditions having been reported upon separately.



## SOME DEFINITIONS

Before proceeding to the discussion of the soil and other conditions in the region in order to secure clarity and brevity of statement it may be desirable to briefly define some of the terms that are used in a quite definite and restricted sense, following the usage of Shaw 1/.

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1/ Shaw, Chas. F. A definition of terms used in soil literature. Proceedings First International Congress of Soil Science. Washington, 1928, pp. 38--64.

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Texture is a term indicating the coarseness or fineness of the soil mass; the combined or mass effect of the different sizes and quantities of individual grains or particles making up the soil.

Structure is a term expressing the arrangement of the individual grains and aggregates that make up the soil mass.

Soil profile is the vertical section of the soil from the surface to the underlying unweathered material. A horizon is a layer or section of the soil profile, more or less well defined, and occupying a position approximately parallel to the soil surface. This differs from a stratum which is a layer of material whose character was established during formation and is not due to subsequent alteration by weathering.

A soil series is a group of soils having the same character of profile--(the same range in color, structure, consistence, and the same sequence of horizons and degree of horizontal development), the same general conditions of relief and drainage and usually a common or similar origin and mode of formation. A group of soil types closely similar in all respects except the texture of the surface soils. The series is the most important in soil classification as it expresses in full the profile

differences. It is the unit of most soil classifications. The series name is usually a geographic name occurring in the region where the series was first noted and described, but it no longer retains its geographic connotation.

A soil type is a soil which thruout the full extent of its occurrence has relatively uniform texture of the surface soil and relatively uniform profile characteristics. The type is the unit of soil mapping on a detailed scale. The name of the soil type is a combination of series name and the textural grade designation, as for example Pakhoi sandy loam.

The basis of soil classification used in this report is the same as already employed by the Soil Survey of the Agricultural College, Sun Yatsen University, Canton, and by the Soil Survey of the National Geological Survey, and is the most generally used in the world at the present time, and is coming to be used more and more extensively, as it most effectively expresses the soil features of importance, and the genetic development of the soils. Thus far, for China, altho Shaw has proposed broader soil groups as a tentative grouping, the soil surveys made have been quite too limited and too recently carried out to have provided adequate material for the full development of the broader soil groups.

The soil map as prepared for this report is necessarily very incomplete, due to the limitations pland on the work, as enumerated above. Additional information might have been included from the soil survey of the Panyu area, if there had been available a copy of the map of that area. But the map has not yet been published.



### GENERAL SOIL DESCRIPTION

Due to the great extent of country covered in this study, and the extremely diverse conditions topographically and geologically, as well as the variations in the climate, and in places the intense and long continued utilization of the soil for very specialized crops, the characteristics of the soils are very diverse.

The most important single group of soils is the recent river alluvium, best represented by the Chuk'iang series around Canton. This soil is important because of the high yields of rice, due to its relatively high amount of available plant food and its almost universally good supply of water for irrigation. Along most of the lower courses of all the rivers and streams there is more or less recent alluvium, but there has been no opportunity to study the characteristics of these soils in detail. Attention must be called to the marked differences in productivity that exist between the true alluvium, and some relatively very deeply weathered materials that, as about Canton, occupy low-lying tracts and which might judged by their topography to be recent alluvial material. These other soils are, as shown by their profiles, very different, and this is demonstrated in their productivity, which is much lower.



Along a number of the rivers, there are older alluvial soils, lying higher above the flood levels of the rivers, and only partially utilized for the production of irrigated crops. They are older soils, yet fertile and quite productive.

The most important upland soils are those of the Pakhoi series, which occur over large expanses of the province, between Muiluk and Pakhoi, and extending southward thru much of the Luichou peninsula and on Hainan Island. Very likely there are soils of similar nature east of Muiluk, along the coastal country for considerable distances.

Residual soils occupy the rest and by far the greater proportion of the region. As to value or importance their great extent in area is more than offset by their generally steep topography, shallow depth, frequently their poverty in plant food materials, their liability to erode, and in general their unsatisfactory nature for agricultural purposes. There are some exceptions, such as the Chumen clay loam which is deep, fertile, and well adapted to many agricultural crops. The vast extent of hill and mountainous lands in the region, and the great diversity of geological formations, combined with climatic and other differences, have resulted in the development of a vast number of sorts of hill soils, so that it is possible to describe only a relatively very few of the number that

probably occur. A suggestion of the number and diversity is given by Tang's descriptions in the Soil Survey of the Panyu Area. South and southeast of Kochou there is a locality with very old soils, deeply weathered, and infertile, which probably are best grouped with the residual soils, tho it is difficult to place them with certainty.

The "Rice soils" which are soils diked and flooded for the cultivation of lowland rice for a greater or less period of every year, depending upon the supply of water, the climate, and the agronomic practices of the locality, are artificial modifications of the other soil groups. Because the modifications have often been extensive, due to the long period of flooded conditions, they should be considered separately. However, in the field work reported here, conditions did not permit their being given enough attention to permit their being adequately discussed.

The relation of the soils to the natural vegetation is very difficult to determine, because of the extensive and generally almost complete deforestation which has occurred, and which deforestation, as Fenzel describes, to a great extent is maintained by repeated burning where the brush, trees grass and ferns are not used directly for fuel.

ROUTE NOTES RELATING TO SOILS SEEN IN THE PROVINCE.

There follow route notes relating to the soils. These notes are for the most part arranged according to the order in which they were seen, commencing with the soils seen about Canton, and in Chungshan hsien. No attempt has been made to repeat the descriptions for the soils near Canton already given by Tang, and which it is hoped will soon be formally published. Rather, there are recorded some notes which might be considered interpretive or supplementary.

See the accompanying route map for locations. Numerals on the map refer to page numbers in the Report where main descriptions of the soils may be found.



## SOILS OF THE CANTON REGION

A number of days were spent in company with members of the Soil Survey staff of the Agricultural College, Sun Yatsen University, endeavoring to become familiar with the main soil series and types in the environs of Canton, particularly those mapped in the Pan Yu district. 1/

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1/ The report on the soils of the Pan Yu district was available in mimeographed form but there was no extra copy of the soil map. It was, therefore, consequently necessary to study the original map in the office, make tracings of the portions of the district to be visited and when travelling to use these tracings assisted by Mr. Pan or others in interpreting the soil conditions as found.

No effort will be made to repeat the descriptions by <sup>P</sup>Tang as given in the above-mentioned report. Rather, there here follow comments and notes of the writer's observations which would serve rather as a supplement. Because it was impossible to take the manuscript soil map into the field and also because this map did not carry as much topographic or cultural detail as would be desirable, it was often found impossible to gain a clear idea of the soils as they were actually classified and mapped in any particular locality. Some of these divergencies will appear below. As the Soil Survey of the province has requested assistance in solving some of their difficult problems in field classification, it is regretted that there was not opportunity during 1932 to give them the assistance desired.

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THE SOILS OF THE CANTON REGION BELONG TO THE FOLLOWING  
MAIN GROUPS:

Residual soils: These have been derived either from the <sup>2</sup>ganitic rocks (Lokong series), or red bed formation, (Canton series), and lower hills and slopes of material from other formations. (Shihpai and others).

Alluvial soils: In the smaller valleys are the Lungyentung and other series. The soils of material deposited by the Pearl River and its tributaries forming the most recent and most fertile soils of the region are the Chukiang series. Of the other series a satisfactory conception was not obtained in the field, at times because the information gained in the field seemed to conflict with the published descriptions and map locations.

LOKANG SERIES

These soils have been derived from the weathering of <sup>or other igneous rocks</sup> granites. In color they are a reddish brown, the subsoil usually being a lighter color. Due to the large amount of coarse quartz sand and gravel from a distance, the material on the surface often appears a light brown to whitish colored even when the soil is moist. At times the soil mass is practically all a uniform brownish red to purplish red, to even as much as 8 meters depth.

Figs. 8, 9 (110-3, 4) 1/. In other cases, Fig. 12 (110-7),

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1/ Numerals in parenthesis refer to photograph numbers of the figures which accompany this report and which may be found in the illustrated section of this report.

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there may be a gravel layer at about a meter. There is a wide range in the depth of the weathering and the soil mass. Contrast Fig. 13 (110-9) where the surface soil is a reddish brown, and is underlain by many meters of mottled red and white decayed granite, with Figs. 60, 61 (117-1, 2) where under a similar topography, tho higher up the slopes, the soils are relatively very shallow, and the underlying rock very much less altered by weathering. Here and there, Fig. 4 (109-11), the soils of this series are marked by scattered large granitic boulders, particularly on the hill tops.

The soils belonging to the Lokong series are important because they are extensive in area. And since they are so very poor in plant nutrient materials, the difficulties of afforesting or growing other crops on them is very great. Because of these facts and because they are inherently easily eroded, the soil erosion problems are very serious. Figs. 4, 5, 6, 8, 13, 14, 34, 35, 36, 37, 38 (109-11, 12; 110--1, 3, 4, 9, 10; 113--3, 4, 5, 6, 7). Heim et al. call attention to



this in their report on the Geology of Canton. In other cases, however, where the soils of this series have been derived from somewhat schistose materials Figs. 60, 61, 62, 63, 64 (117--1, 2, 3, 4, 5), the erosion is relatively very slight. The soil surface in roads or other place where it is tramped hard or the surface material has been washed away, shows a curious cracking into polygonal, often hexagonal blocks Fig. 10 (110-5). In the utilization of this soil what seems to be most needed is some leguminous tree, or a leguminous nurse crop, to enable plants to get a good start, which is impossible under present conditions. It is even possible that when starting <sup>non-leguminous trees</sup> ~~these~~ it would be justified to use ammonium sulphate or night soil for supplying nitrogen. ~~xxxxxxxxxxxx~~

For additional views illustrating soils of this series see Figs. 15, 16, 33, 42, 43, 44, 45, 48, 66, 67, 68 (110-11, 12; 113--2; 114--1, 2, 3, 5, 11; 117--7, 8, 9).

#### CANTON SERIES

The Canton series of soils, chiefly the sandy loam type, has developed on the "red beds" formation which as a whole occupy lower hills than in the case of the granites under the Lokong series. These soils of the Canton series are a deeper red, finer textured, and the

rock material is not nearly so deeply weathered as that of the Lokong soil derived from the granites. This is partly at least the reason for a relatively much less serious degree of erosion. The soils of the Canton series as near the Sun Yatsen University farm are a brownish red or light reddish brown. As the soil here is much shallower and lies more directly on the steeply dipping ( $30 - 40^{\circ}$ ) beds of shale, sandstone, or conglomerate, the soil profile is not distinct and has been greatly disturbed by graves, roads and cultivation.

The peculiarity of the <sup>sub-</sup>soil of this series is the whitish bodies or veins, a few centimeters to a decimeter or more in length, of whitish or whitish and reddish clay. Also in places in some of the deeper strata there are irregular black concretions with whitish material inside. These white and black portions are in some strata, but usually do not lie closer to the surface than one or two meters. Apparently, therefore, they are not due to a more intense weathering at the surface.

A profile in the Canton series, east of Shekpai Station is shown in Fig. 20 (111-7). The white and red mottlings are very conspicuous. For scale note the soil pick handle which is about 42cm long. This profile is really an example of weathering inclined toward the

lateritic type. Limonite concretions, however, have barely begun to develop around cores which seem to be of sandstone. This limonite, however, is not very shiny, nor very regular. In places where it is exposed on the surface of the cut, the red skeleton work shows a tendency to persist, and the whitish kaolin material to erode away. There seems, however, to be only a very slight tendency for the red skeleton material to develop a limonite varnish or covering typical a true laterite. In this profile the surface soil is only moderately developed. It has a dark brownish red to brown color. In texture the surface soil varies from a loam to a gravelly loam. The now deeply weathered parent material of the mottled substratum is clearly a conglomerate member of the red-beds. Some of the quartzitic boulders and cobble stones strongly persist in the deeper portions of the variegated red and white matrix.

A good deal of the Canton sandy loam seems to have the typical deeper lying lixivium mottling as seen in 1931 in excavations at Lingnan University and which are more or less typical of mature tropical upland soils. As a whole the Canton series of soils probably are not as deeply weathered as the Lokong series. These is another phase of the Canton series which does not seem to have this mottling.



For illustrations of the Canton series see the following Figs. 1, 2, 3, 21, 23, 24, 51, 53 (109-7, 8, 9; 111-8, 11, 12; 116-3, 5). These not only show the topography of the Canton series but also the relation of this series to the soils of the surrounding lowlands. ~~Fig. 67 (117-8) shows the Canton series as it is sometimes terraced for the planting of tree crops as well as annual field crops.~~

#### LUNGYENTUNG SERIES

As shown in Figs. 1, 3, 7, 11, 12, 32, 35, 36, 65, 66, 67 (109-7, 9; 110-2, 6, 12; 113-1, 4, 5; 177-6, 7, 8) the soils belonging to this series occupy relatively narrow valley bottoms or lower slopes and are quite definitely outwash material from the hill-slopes occupied by the Canton and Lokong series. For the most part these soils are devoted to rice culture and consequently have been much modified by the terracing and sub-aqueous conditions demanded by this crop. They are also considerably affected by the continuing wash of material from the hill-sides of Canton and Lokong soils. In a good many places, however, these rice fields are protected by lateral ditches at the foot of the slopes, to lead away the excess material eroded, Fig. 7 (110-2).

In a road-side borrow pit a few km north-east of the University farm we found the following soil profile, Fig. 65 (117-6):

- 0 - 10±cm - grey clay loam
- 10 - 25±cm - grey clay
- 25±cm and downwards - a white sandy clay.

If this and some other exposures be typical, it indicates that this soil profile is probably fairly mature, and has been developing along similar lines to those of other series which have been derived from other formations, such as the Shihpai series. This is of course to be expected.

#### SHIHPAI SERIES

This series occupies an intermediate strip between the Canton and the Chuk'iang series, and also narrow valley floors surrounded by soils of the Canton series.

As a whole the soil is a light yellowish brown, with in places a shallow soil and an almost white or yellowish white subsoil, with red tinges here and there Figs. 23, 25, 28, 50, 59 (111-11; 112-1, 4; 116-2, 11). A profile along the north road, Fig. 29 (112-5), shows:

- 0-30 grayish brown clay loam
- 30-- light bluish white, red spattered sandy clay
- Crop: rice; some truck also

Another roadside profile, Fig. 30 (112-6), shows:

- 0--10 to 20 cm grayish brown soil;
- 10 or 20-- light bluish-white sandy clay with red spots.
- lower portion of the profile obscured by standing water

Another profile north of the city, Fig. 49 (116-1), shows from a boring, in a much disturbed locality:

- 0--50 cm yellowish gray clay loam
- 50--75 cm variable
- 75-- whitish yellow clay

North of Canton the first plains are mapped this series, while farther north the soils are classified the Fuling series altho I failed to see in the field any important body of the Fuling series. The validity of the separation between the Lungyentsun, as in Fig. 65 (117-6), and the Shihpai to the east, or between it and the Fuling as mapped to the north is not clear. There seems to be at least in some places under soils of both series the same whitish subsoil (with red splotches or stains) appearing close below (15--20 cm) the brownish gray soil.

Rice, the principal crop on this series, is noticeably poorer than on the Chukiang series. As a whole the water table is not so near the surface as in the Chuk'iang series. More of the fields are in garden crops, east of Canton.



### FULING SERIES

Contrary to the published description, and the indicated location of this type on the map<sup>of the Panyu District</sup>, there was actually pointed out only one little patch of about half a hectare of a low hill of black shaley material Fig. 52 (116-4). This knoll had been dug over to supply material for adulterating coal. This Fuling soil was entirely non-agricultural where seen.

According to the map the plains north of Canton are in part Shihpai series, and bounded on the north by the Fuling series. But except for the small body of hilly Fuling soils seen, none were located in the field, so the actual<sup>normal</sup> profile relations could not be determined.

### SHIUPING SERIES

Soils said to belong to this series are shown in Figs. 51, 53, 54, 55 (116-3, 5, 6, 7). There seemed to be some doubt as to the validity of this series in the places where it was seen along the north road.

### KIANGTSUN, CHUNGTSUN, FULING, AND LANTAN SERIES

There are so many divergences between what was pointed out to me in the field as these series, what the map indicated, and what the published descriptions showed, that it has been impossible to obtain a satisfactory conception of the soils of these series as they actually exist.

The soils indicated in the field as Lantan series are presumably the same as mapped and reported upon as the Kiangtsun series. The types seen were a gray to light brownish gray sandy to coarse sandy loam on a light yellowish brown clay loam to heavy clay loam subsoil. Apparently there were no differences made between the higher and lower portions of the type, or between old stream beds, grave covered slopes, or upper flats or plains. Figs. 56, 57, 58 (116-8, 9, 10). Actually these topographic differences are very important in characterizing the soils and affecting soil properties and are often of series importance. A portion of this soil is quite low Fig. 58 (116-10), and on June 30 '32 was actually submerged a meter or more of flood water.

#### CHUK' IANG SERIES

The profile characteristics of this series were difficult to see during June to August, the rainy season, with the rice crop well developed. The water table is near or even above the surface, so that if any upland crops are planted, they have to be placed on elevated beds to free a little of the surface soil from excess moisture. <sup>At least some of</sup> the soil is heavily contaminated with potsherds from fertilization with garbage, heaps of which were seen on the field edges, ready for application Fig. 19 (111-6).

The soil is a medium dark gray color and is probably grayer because of addition of these fertilizer materials. Some of the subsoil as seen exposed in borrow pits along the road is a light yellowish to almost white. This is probably near the boundary of the Chukiang and the Shihpai or Lungyentung series, which latter are characterized by these very light colored subsoils, Figs. 17, 18, 21, 47 (111-4, 5, 9; 114-9).

#### POND MUD

From ponds used for irrigation water storage, or from canals, mud from the bottom is obtained. When dredged out this material is soft and sticky, as it dries it hardens to a solid mass, which then cracks and weathers down to small nuts or cubes 1/2 to 3 cm in diameter.

The color when moist is dark bluish gray to black, and when dry a light bluish gray to gray or dark gray. The darkness of the color depends upon the amount and nature of the organic matter. In extreme case the material leaves a black stain on the hands, typical of soil materials high in decomposed organic matter. Some samples of this material are reported to show as much as 19% organic matter. (Mr. Pan) These pond muds are applied to gardens or used for potted plants. (See sea mud p. \_\_\_\_).



CHUNGSHAN HSIEN

The region which lies just north of Macao, has drowned topography, or is one of recent subsidence, with the very flat plain of alluvial soils extending close to and about the steep mountains; or farther towards the northeast, with lower foothills between the alluvial plains and the mountains. The hills for the most part seem to be of granites. Many of the lower hills are of moderately to very deeply weathered material.

The soils are consequently of two main groups:

(1) The granitic hills and mountains, which for the most part are Lokang sandy loam, light reddish brown to light brownish red, the surface few cm being darker with organic matter. Road cuts Fig. 45 (114-5) show the material to be weathered to 3 to 6 m depth, with still some hard residual granite rock in place. The deeper material shows a beginning of the splotched red and white mottling, characteristic of the deeper lateritic weathering, but even in reasonably fresh road cuts it is seen to be only moderately started. The soil is mature, but probably not senile. As a whole the soil is not at all fertile, and non-leguminous crops do not do well. Erosion has commenced where the cover is broken, and some hills steeper and more rocky have already lost most of their soil. As a whole, local farmers do not use this soil for anything but pines and

grass. The new plantings of other crops or trees on the University Farms, are not promising. The soil is poor, tree or pineapple growth poor, and serious erosion is commencing. Groff has described recent experiments in the cultivation of these soils.

(2) The flat recent alluvial soils. The principal series is the Chuk'iang. No borings were made in these soils, but as far as observed in borrow pits the subsoil seemed to be typical, for no light colored subsoils were seen in any case, Fig. 47 (114-9). The very recently deposited soils, at times still salty, are probably to be classified into another series. Between high and low tide levels these very recent deposits are planted to sedges. After about three years the mud accumulates to an added depth of from  $1/3$  to 1 meter. Then a dike is built to keep out the brackish water, and rice is planted. Double planting is employed, with two varieties with close planting dates, but very widely separated harvesting times, one ripening before the high water period of mid-summer, and the other afterwards, late in November. Figs. 39, 40, 41 (113-8, 9, 10).

It was reported that while no lime was applied to the soils of the lowland Chuk'iang series, all the older, higher small valley soils are regularly limed. No rates of application or costs were obtained.

ALONG THE CANTON--SAMSHUI RAILWAY

From the terminus, Shi Wei Tang, to west of Fatshan, the country is all flat and lowlying, Figs. 69, 72 (118-9; 119-1). The soils are presumably the Chukiang series. These soils are planted mostly to rice, which crop was being harvested on July 4th '32. Between the hills and as far west as Samshui were the same flat-lying recent alluvial soils, probably of the same series.

A few miles west of Fatshan the first ~~low red~~ hills were seen. These have <sup>red</sup> soils apparently either of the Lokang or Canton series. The hills had previously been considerably terraced, but these terraces are not now cultivated, Figs. 70, 71 (118-10, 11). Still farther west was noted some deeply weathered red to purplish red material presumably the Lokang series. Fig. 71 (118-11). There was also noted some quarried basalt, quite fresh and unweathered. In the railway cut were some spheroidally weathered boulders. The soils here were a bright brownish red, very granular, about 3/4 m deep, seeming to be browner, and less purplish red than those of the Canton series. Just east of Samshui there was noted some serious erosion of the hills.



WEST OF SAMSHUI, UP THE WEST RIVER

Near the town and farther west, beyond the junction with the North River, there are dikes to prevent the alluvial plains from being flooded. Fig. 75 (119-10).

A few kilometers west of the town are deposits of older alluvial material, exposing banks from 3 to 4 meters high where they have been cut into by the river, Fig. 73 (119-8). The profile is about as follows:

- 0--.5m grayish brown soil
- 0.5--1.5 m red gravels
- 1.2--4m purplish red
- 4-- gravelly at the water level

Along the south bank of the river, east of the junction, are some low hills of Canton or Lokang soils. West of the junction with the North River are higher hills, Fig. 76 (119-11). A few of the lower slopes are terraced, but a great proportion of the slopes are covered only with grass.

ALONG THE WEST RIVER WHERE IT IS THE BOUNDARY BETWEEN  
JUNGON AND TAKHING HSIENS, AND WEST TO NAMKONGHOU.

The topography is mountainous, with quite steep hills, 200--400m high, and also lower rounded hills, of deeply weathered material. There are only here and there small flood plains, but not over 100 to 200m wide. Figs. 77, 78, 79 (120-1, 2, 3).

The soils in places are brown to light brown or reddish brown, with redder subsoils; at least thus the hill soils appear as viewed from a boat on the river. In other places the soils are red, with deeper material purplish red, with occasionally a whitish color. These latter soils probably belong to the Lokang series.

The steeply sloping soils are cultivated here and there. The few terraces that were seen, were mostly abandoned, the cassava, taro, and upland rice being planted on the steeply sloping fields. In places the erosion is very serious, occasionally with very steep ravines, and elsewhere with a more general sheet erosion.

#### THE LOTING RIVER VALLEY

Topography: Along the river the hills as a whole are steep; here and there are small alluvial terraces or lower slopes that are cultivated with or without terracing. Figs. 80-91, 93 (120-4, 6, 7, 8, 9, 10, 11, 12; 121-1, 2, 3, 4, 6). From Shū Yū Kong southward there is more or less of a valley, from 1 to 2 km wide in places, Fig. 93, 94, 95 (121-6, 7, 8). Farther south the valley narrows, and the road crosses hills which are low, of "red bed" material, and but slightly weathered, Fig. 96 (121-9). The hills about the valley are variable in height and topography, and of various materials. Some are shales

and clay stones, slightly metamorphosed. But nearly half are limestone, as indicated clearly by the characteristically irregular, projecting rocks. Southwest of Taiwan the valley opens out, with a development of rolling, low hills and valleys, the whole terraced, and practically all cultivated. The valley floor is about 10m above the flood level, and was developed at an earlier level of the stream.

The soils north of Shū Yü Kong, judging from what little could be seen from the river, are mostly brown to grayish brown, with a light brown subsoil. This is what would be expected from the nature of the rocks and the steepness of the topography. In some places, the soil exposed by erosion is redder. Where the ferns were cut off the soil surface appeared very dark. This is not the soil color, but that of the organic matter on the surface.

#### THE VALLEY NORTHEAST OF LOTING

South of Shū Yü Kong the soils are variable. Those of the valley appear to be relatively recent, with no visible cases of the red and white mottling in the subsoil, which is so common about Canton and Macao, and as far west as Samshui. The hill soils are red or brown. On the limestone hills there is a redder granular soil which seems to erode more readily, washing away com-



pletely down to the rock. Apparently the reason for these soils showing so much more serious erosion is that the more granular structure common to soils derived from limestone, facilitates the erosion. The soils on metamorphic or **granitic** rocks have not so marked a granular structure. It is believed that from the differences in nature and degree of erosion there can be detected from a distance of several kilometers the differences in the parent rocks. Near Taiwan, on the red beds the soil is red, but the material is not weathered to the degree that the Canton series of soils is, Figs. 96, 97 (121-9, 12). There is little erosion, but the few hills that are eroding have bare red soil with numerous very small pines. In these cases there are near-contour or gently sloping ditches around the base of slopes to divert soil wash, keep it out of rice fields in the valley bottoms, and lead it directly into the river. In a few cases very considerable alluvial fans are being built up at the foot of hills, due to erosion of the slopes. In one case the level of the valley floor near the highway had been so much raised that one of the old bridges now has the floor at about the water level of the rice, and a new bridge has been built above, at a level about 1.7m higher.

North east of Loting the soil is as a whole brown or grayish brown rather than red or purplish brown, even tho it lies on purplish red beds. The weathering is certainly not deep. A mature profile has apparently not yet developed in this soil.

The crops in this region are the usual ones: rice on the irrigated plains, with some hemp; and peanuts, cassava, some tobacco and sesamum on the terraced slopes.

Between Loting and Taiping there is a considerable plain with low hills scattered thru it, and higher mountains in the distance. On the rolling lands the soils are brown, with a reddish brown to red subsoil. At least a part of the parent material seems to be red beds. In one place, where the road goes thru a pass in the hills, the road cut showed a grayish brown shallow surface soil on brown shales. Near Taiping the lowland rice soils are medium dark gray, 20-30cm thick, on a light gray or light yellowish gray to white clayey subsoil. South of Taiping the dark soil is shallower (about 10cm), and the subsoil yellowish, Fig. 101 (122-5).

Probably started from fuel gatherers' trails, the hills in places are eroding badly. Some single ravines occupy several hectars (20--50 mow), and in places a considerable lowland area is covered by the deposits. In places the older terraces on the lower slopes of the hills have been abandoned, and are eroding.

The crops are rice, with the upland crops peanuts, sweet potatoes, etc. Figs. 98, 99, 101, 102 (122-1, 2, 5, 6). The rice is often poor. Each of the two crops a year of rice is limed, with the applications from 1/3 to 3 piculs per mow (300--3,000 kg @ Ha) of lime per crop. The cost of the lime was reported to be \$3. @ picul (\$50 @ metric ton) making a very heavy cost. Probably the statement was \$3. @ mow which would be \$16. @ ton or \$50 @ Ha still very high, Fig. 100 (122-3). Some rice is fertilized with ashes of grass and ferns, heaps of this material being noted in various places in the fields.

#### THE HILLS BETWEEN TAIPING AND HAPSHUI

Between Taiping and Hapshui the topography is that of hills and low mountains, with only a narrow valley along the stream, Figs. 103-118 (122-8, 9, 10, 11, 12; 123-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11). A few of the rocks are shales or thicker clay-stones, partly metamorphosed to schists, tho the great majority of the rocks seem to be a very coarse grained "granite" with quartz grains 1/2cm or larger in diameter, weathering to a gravelly soil. The weathering is moderately deep, but the slopes are often quite steep, and there is relatively little accumulation of soil. The resulting soils are shallow, and the profiles not mature.



The soils are variable. Most of the rice soils were covered with water and a standing crop, and so they were not visible nor easily studied. However, there were numerous fresh exposures in cuts along the new road alignment. These cuts normally showed the following profile: Fig. 107 (122-12)

0---5 cm Clay loam, dark, with organic matter coloration.

5--50 to 100 cm bright yellow gravelly clay loam grading into a clay below.

50 to 100 and below: reddish brown to brownish red gravelly clay loam.

As viewed from a distance this substratum gives the impression of red on terraces or freshly cleaned grave plots. Graves in this region are often high on the slopes, above the terracing, and the grass and sod are repeatedly cleaned off.

Where the soil has been terraced for irrigated crops the disturbed soil seems to be all gray, and the underlying to be a light yellowish brown or reddish brown, Fig. 110 (123-3). It is not easily explained how the deeper material can retain such a bright color.

Erosion is very slight along this valley, except that at places there is some sliding into the road, Fig. 110 (123-3).

HAPSHUI

The valley here is broader, surrounded by fairly high hills. To the south are higher mountains, nearly 1,000m elevation above sea level, Figs. 119-142 (123-12; 124-1,2,3,4,5,6,7; 125-1,2,3,4,5,6,7,8,9,10,12; 126-1,2,3,4,5). Granite seems to comprise a good deal of the rock of the region.

The soils on the valley floors are the usual light bluish gray, about 20--30 cm deep, depending upon the terrace formation, and nature of disturbance. Below that is a light yellowish clay, Fig. 127 (125-1). A soil under a sweet potato patch, Fig. 138 (126-1), showed the following profile:

0---30 cm gray  
30---32 cm brown  
32---37 cm gray  
37---39 cm brown  
39 -- downward light gray

Even when not always flooded, these flat terrace soils are also gray, probably due to heavy fertilization with ashes and manure.

On the slopes the soil seems reddish from a distance, where cuts are exposed, but the hills soils at the surface are actually grayish brown; below, a light yellowish brown, and reddish at about 0.5m. Figs. 120, 136 (124-1; 125-10)  
A typical profile is:

0---5 cm brownish gray clay loam

5--30 cm brown clay loam

30--cm and below, brownish red gravelly clay loam  
Apparently from granite.

In two places near Hapshui there is visible on opposite slopes of a hill the typically mottled and splotched substratum of the lateritic weathering. No where else, even in the deep new road cuts, was this condition found. Being so unusual, it seems likely that this might be the result of some <sup>hot</sup> spring, having caused an increased rate of weathering.

The soils in this locality do not erode at all easily. The terrace walls are steep, and the water runs over the banks from field to field, with seldom any wash noted.

No lime is reported to be used in this valley, for local sources not available. Cow dung is used, also ash of forest leaves, and rice straw ash. The usual upland crops dwarf soy and pole beans, cassava, sesamum, and sweet potatoes are planted on the higher slopes where water is not available for rice. On the forest slopes are considerable plantings of Cunninghamia and some tea for oil seeds, Figs. 135, 136 (125-9, 10).



HAPSHUI--CHIENPAI

Along the trail between these two towns the route passes over the divide where the elevation is about 400 meters, or more. The valley becomes rapidly narrower, and steeper, and the mountains higher and almost entirely grassy toward the tops Figs. 142-147 (126-5,6,7,8,9,10). West of the pass the route leads down thru another valley, apparently with a higher elevation of the floor. The mountains, particularly toward the south, continue high. Figs. 152-159, 162-166 (127-3,4,5,6,7,8,9,10; 128-2,3,4, 5,6). The relief map of the region does not show the topography correctly in this locality.

The geology and petrography of the region continue obscure. There are considerable areas where there is granitic material, with large boulders, Fig. 146 (126-9), but in much more of the region the more or less metamorphosed sedimentary materials are predominant. For the most part, tho the slopes are rather steep, there has been quite deep weathering Figs. 148-153, 155, 160, 161 (126-11, 12; 127-1,2,3,4,6,11,12). West of the pass there seem to be more schistose rocks, and less granitic.

The soils on the slopes for the most part are brown, or reddish brown to gray brown. They seem more red when viewed from a distance. Under sweet potatoes, Fig. 148 (126-11), was the following profile:

0-20 to 30 cm brownish gray

20 or 30---downward a medium brown

And under grass and open pine forest, Fig. 149 (126-12) was the following profile:

0--20 to 40 cm gray soil

20 to 40 and downward, yellowish brown

And again, Fig. 150 (127-1);

0--40- cm brown to grayish brown,

40-- and downward, yellowish brown, friable.

Near the highest part of the pass was the following profile:

0--20 or 30 cm medium gray

20 or 30-- and downward, subsoil yellowish and reddish streaked.

Farther west, down the valley, are more red soils in places, Figs. 160, 161 (127-11,12), which are very deep. Under a sweet potato field the soil was:

0--15 to 30 cm grayish brown

15 or 30-- downward red. In some places this material erodes badly.

Where there has been intensive cultivation, and fertilization, the soil is gray, Fig. 157 (127-8).

The lower soils to the west seem to be more micaceous, and grayer than to the east.

The upper part of the valley to the west, the Chienpai valley, has less intensive utilization of the upper hill slopes, there are fewer terraces and less forestry work. Also less of other crops than rice, tho there are many sweet potato plantings, at times at least, heavily fertilized, Fig. 157 (127-8). The forestry is less, doubtless because of greater isolation, and no accessible market. There may be less rice on terraces because of limitations of water for irrigation, due to less watershed above; or possibly because the soils are more schistose, and seem to slide more. Erosion as a whole however is not at all serious.

The hills as a whole have less cover. The bare upper slopes <sup>are</sup> probably due to burning, tho local reports differ. The lower slopes that are bare have had the soil dug up and burned with the grass for fertilizer.

#### CHIENPAI VALLEY AND ENVIRONS:

The topography of the locality is that of a relatively narrow valley, with some scattered hills here and there in the small plain, and with some side valleys. There are lower hills, and higher mountains on the north and south Figs. 165-173, 175-188, 190-198, 201 (128-5, 6, 7, 8, 9, 10, 11, 12; 129-1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12; 130-1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12; 131-1, 2, 5). The rocks of the region are at least partly granitic and schistose; deep weathering and lack of fresh exposures left the matter obscure.



The soils of the plains and lower terraces seem to be generally a medium to dark gray, 20--30 cm deep, with a light yellowish brown, yellow, to whitish clay subsoil. A higher irrigated rice terrace showed, Fig. 199 (131-3), the following profile:

0--30 cm gray soil

30-- and below; a mottled red

Another rice field profile, Fig. 200 (131-4), showed

0--30 gray soil

30-- below, a red subsoil, with a quartz vein in place, indicating that the soil is residual, and weathering has been very deep. Under a sweet potato field, Fig. 202 (131-6), the soil was gray, the subsoil below, whitish. The hill soils, where more profiles were seen, seem to be more variable, doubtless depending at least partly upon the treatment and degree of disturbance. In places these are a gray to yellowish brown clay loam, with red subsoil and substratum. Where terraces are made there is much red exposed on the banks, and the dry cultivated terraces are brownish gray to reddish brown, Fig. 169-170 (128-9, 10). The wet cultivated terraces are gray. The gray color is intensified by fertilization with a "compost" of night soil, rice hulls, garbage, etc. Lime also is used.

The soils on the higher hills and mountains Figs. 186, 203 (130-2; 131-7), have a thin layer, about 5cm, sometimes thicker, Fig. 175 (129-3), of dark gray to dark brown soil, with a brown to light brownish yellow to light yellowish brown clay loam below. They are very finely granular, friable, but otherwise structureless.

Crops: At the present time there is a great difference in the degree to which different hill slopes are cultivated, and reasons for the differences could not be learned from observation of the conditions nor from local sources. The pressure of the population for food is considerable, tho the conditions at some previous time must have been more severe, as the higher peaks show evidence of having been formerly cultivated, Figs. 175-178, 182 (129-3,4,5,6,10). It is however possible that these traces of activity are the result of cultivation of Cunninghamia, and its nurse crop **cassava**. Forestry at present is good in spots. See Cunninghamia Figs. 188-192 (130-4,5,6,7,8)

Erosion as a whole is not serious. In some places there is heavy pasturage particularly by goats, and erosion is commencing. Landslides seem to be serious in one locality, Fig. 204 (131-9).

CHIENPAI--TUNGCHEN

Southwest of the pass out of the Chienpai valley is another valley long, quite straight, and with much lower hills on both sides, as far as Ssü Fang Tien. This valley is shown from opposite ends in Fig. 174 (129-2) and Fig. 216 (132-12). For other features note also the following Figs. 205-216 (131-11,12; 132-1,2,3,4,6,7,8,9, 11,12). West of Ssü Fang Tien the stream of this valley traverses a double deeply entrenched meander Fig. 217-220 (133-1,2,3,4) and then flows thru a country of hills and very small valleys Figs. 221-224 (133-6,7,9,10). From the high ridge west of Pak Shek there is a big drop to a lower valley or succession of low hills and valleys Fig. 226 (133-12).

Soils of <sup>such of</sup> the rice fields as were seen in profile as a whole are gray, as usual. In one place the profile showed dark gray, yellowish brown, and below a gray, Fig. 214 (132-9). Many of the slopes showed a brown soil, particularly where the soil had not been terraced. In places the soil of the higher hills, exposed by erosion, is red Figs. 206, 214, 215 (131-12; 132-9, 11).

Some exposures of both granites and schists were seen, but as usual, the deep weathering obscures a clear idea of the geology <sup>and petrography</sup>. Farther to the west, near Pak Shek (Shek Lung bus station), are more deeply weathered schists,



which are not mottled, but give rise to dark red soil and subsoil material, Figs. 221, 224 (133-6, 10). West of Pak Shek the rocks are seemingly almost all the same, schists and granites, but all give deeply weathered and reddish brown to **bright** red soils. In one place there appeared to be some limestone quarried.

The crops of the region as usual are largely rice, with some upland crops. Forestry makes a better use of the hills, Figs. 210, 211, 217-220, 222 (132-4,6; 133-1,2, 3,4,7), probably because of a stream suitable for floating the poles out, and the road that makes possible truck transportation, Fig. 224 (133-10). There is some fruit in the house yards. West of Pak Shek many of the hills are planted thickly to Cunninghamia, the stands seem good, the growth vigorous. Farther west, the lower hills have a little pine, little or no ferns, a good deal of bamboo, but no Cunninghamia, Fig. 226 (133-12). The climate is said not to be suitable, but <sup>there</sup> ~~it~~ is some doubt as to the real reasons.

Some of the lower hills, east of Tungchen are eroding badly, and have deep ravines. This greater erosion is probably due to heavier pasturing and a greater population pressure.

TUNGCHEN--KOCHOU

The topography is that of low hills, with some higher ones, and with the side streams and rivers in relatively very narrow valleys. There are some alluvial plains in places as wide as 3 or 4km. Apart from the narrow plain northwest from Shunyu, which is lower due to the aggrading river bed, the plains along the main river are from 5 to 8 meters above the ordinary stream level.

The rocks in this region are very deeply weathered, and as a whole cannot be recognised. Some of the material about Shunyu seems to be weathered from granite, while hills about Kochou in places show shales and schistose rocks. Between Shunyu and Kochou there is a limited exposure of "red beds". In places there is seemingly diluvial material, as rounded gravels and quartz pebbles would indicate. South of Shunyu there are lower hills of **such** reworked materials with a good deal of gravel.

Judging from the color of the erosion scars all along, the soil of the region, or at least the subsoils, are very generally red. This may be somewhat of a misconception, for it seems to be that the redder soils erode worse, while the light yellowish and browner soils do not erode and show their colors. In other cases, in erosion scars there has been some red material washed down over yellowish and grayish brown mottled material,

thus giving the appearance of red to the whole mass, when only a relatively small part of it is of that color. The red is in part diluvial material that exists as cappings on some of the hills that are apparently of residual granitic rock, Fig. 242 (137-2). In no place was there found a real lateritic soil. The subsoil is blotchy, showing the intensity of the weathering. In a road cut south of Shunyu, the following profile was seen: Fig. 250 (138-9).

0---15 cm grayish brown sandy loam

15--150 cm yellowish brown clay loam

No distinct horizons and no conspicuous structure had been developed. But farther south, in the same hilly locality was a rather unusual development of concretionary material, and the following profile Fig. 253 (139-1):

0---30 or 40 cm brownish gray soil

30 or 40--60 cm brown

60-- and downward. Brownish red and yellow, with iron concretions. Note the iron concretions visible on the road surface. (in the photograph)

In a road cut near this, one case of a cementing together of the smaller iron concretions was seen, but even this would not be considered a typical laterite.

The soil on the hills to the south and east of Kochou 1 to 3 km is a brown gravelly or stony loam, in places eroding very deeply Fig. 271, 273 (141-5, 8).



South and southeast of Kochou, beyond the first low hills the conditions are quite different. The country becomes more open, with only scattering hills, or small groups of low hills, and with nearly level, undulating or only slightly rolling land between. The lower elevations are a gray to light brown loam to clay loam, often gravelly with iron cemented concretions and quartz pebbles. There seems to be a layer of concretions at about 25cm below the surface.

#### KOCHOU SERIES

The hills are of different material, very deeply weathered, and with large quantities of a very much fragmented, relatively thin iron-cemented hardpan. The soil is really a gray stony loam, the stones being iron-cemented quartz sand and gravel, and this material is a hardpan and not a laterite. The hardpan having been dug up and thrown over the surface, as in grave digging and road building, the original profile is much altered. Or it may have been exposed by erosion after intense pasturing and deforestation had changed the conditions and induced erosion, or greatly increased the speed of the erosion, Figs. 260, 268, 269 (140-1; 141-1, 2). This hardpan layer is irregular and broken, lying at about 15 to 35 cm deep.

A profile shown in Fig. 267 (140-11) is as follows:

0--15 cm a gravelly sandy loam; the pick marks the original soil surface.

15--40 cm a broken, irregular limonite-covered hard layer

40-60 cm reddish clay loam

60-- and below, a laminated, iron-cemented layer.

Another road cut in these hills has the following profile, Fig. 269 (141-2):

0--60 cm gray sandy loam

60--80 or 100 cm broken, iron-cemented layer,  
marked by the pick.

80 or 100-- to bottom of exposure; light and  
yellow and red spotted or splotched,  
non-concretionary or lateritic,  
granitic sand.

Farther out in the plain both, southeast and southwest, are some gravelly elevations which are the remains of ancient stream outwash. The gravel in places is cemented by limonite. Still farther to the south are rice lands of medium to light gray soil; while in some places the soil in the depressions is very black, wet, high in organic matter, and poorly drained. These soils will probably correlate with the Lankong series. To the southwest, the area of these soils is considerably greater, and in places it is the predominant type cultivated. These dark, wet poorly drained Lankong series soils are planted to rice the first crop, and sweet potatoes the second. The profile as found by boring in the field shown in Fig. 266 (140-10) is as follows:

0--40 cm black organic loam

40--75 cm black organic loam with more organic  
matter

75--100-- and down sandy clay loam, whitish,  
with yellow and red spots.

The reaction is doubtless quite acid, substantiated by a colorimetric determination showing pH 5. These black soils as a whole are poor and are said not to respond well to fertilizers, that is, to nitrogenous materials. The soils are probably also quite deficient in potassium, as well as needing considerable lime. It is fortunate that as a whole the area of these soils is limited.

Still farther southeast and southwest the soils are a brown fine sandy loam to 20 to 35 deep, underlain by a light brown light clay loam extending to a depth of at least 110cm. There are few iron concretions. On the Sun Yatsen University Mulberry Station the trees are growing well, but they have obviously been well fertilized with lime and manure (pond mud and compost). Lime up to 2 piculs per mow per year (1,900 kg @ Ha) is reported to have been used. At Namsing, besides the slightly elevated portions, which have a grayish brown gravelly loam, the gravels being angular red concretions, and the lower portions, which are the very dark soil; there is an intermediate soil, Fig. 274, 275 (141-9, 10),

0--20 to 30 cm medium brownish gray

20 to 30-- and downward; a light yellowish sandy loam with red spots.

South<sup>west</sup> of Namsing, to Fachou, the soils are not very different. There is an occasional reddish hill with brownish gray sandy soils, and brown to light brown subsoils; the predominant soils farther south are the low alluvial soils.



Many reports, more or less conflicting, were obtained regarding the use of lime in the Kochou region. Some sorts of limestone are thot to give better results than others, and in some cases shell lime is used. It is certain that more information is needed about this important soil amendment, and the location and nature of the limestone that is available.

There were also conflicting ideas and reports about the reputed effects of the use of ammonium sulfate, the only commercial fertilizer known. The first ideas were that it poisoned the soil, but when that was shown to be false, the claims were that the material spoils the soil for the following crops. The subject is one that needs real experimental study.

There are many needs for improved crops and <sup>better agricultural</sup> methods in this region, for the adaptation of better trees and other upland crops to the soils and local conditions. Agricultural implements are notably poor, and the almost entire lack of wheeled vehicles for farmers' use should be made good now that there is the development of roads.

MUILUK-KWANCHOUWAN-LUICHOU PENINSULA

For the soils of the region about Muiluk, and on to Kwangchouwan, and the Luichou peninsula, see below (pp\_\_\_\_) descriptions of the Pakhoi, Chumen, and Lankong series, also Sea Beach and Sand Dunes, Recent Alluvial soils, etc.

SOME SOUTHWESTERN ALLUVIAL SOILS

Tungchen --- Kochou. There is a strip, variable in width, of alluvial soil extending along the river, at least from Tungchen south to Fachou. It is from one-half to two or even 3 kilometers wide, in places flanked on both sides by low rolling hills, Figs. 227-229, 240 (134-1, 4, 11; 136-12). Below Shunyu, Figs. 255, 256 (139-3, 4), and around Kochou, Figs. 261, 262 (140-2, 5), these alluvial soils are actually from five to eight meters above the present normal river level. As a whole the soil is a light greyish brown to light yellowish grey or even a grey in color. The texture is sandy loam or fine sandy loam. The subsoil is brownish red to reddish in color, Fig. 256 (139-4). Those portions of the soil that are planted to rice practically all have the usual dark bluish grey to grey color of submerged soils.

Along the West Fork of the river at Shunyu near the stream, there is loam, fine sandy loam, or sandy loam, Figs. 243, 244 (137-4, 5). Near the stream the soil is mostly planted to soy beans, sweet potatoes or rice, while further back from the river the heavier lower clay loam or sandy clay loam land is practically all planted to rice, two crops per year.

Fachou - Muiluk. The alluvial soils in this region seem to be very irregular in nature. In color they are greyer and apparently of medium to light texture. Nearer the river there is a much larger proportion of hemp being grown. The northern boundary of the main alluvial plain should be drawn about through Fachou, running north-east and south-west. In places, scattered through this plain, are very low bare, red hills, eroding in places. It is probable that these are outliers of the <sup>Pakhoi</sup> upland sandy loam material which predominates south-west of Muiluk and further along the coast. These hills do not constitute more than about 10% of the surface in this locality. In addition to the recent alluvial soil and the hills, there is a grey lower soil 20 to 25 cm thick, underlain by a light yellowish subsoil, probably a clay loam. This soil reminds one of the Lungyentung and Shihpai series near Canton. In places the lighter surface soil is scraped away and heaped up to provide additional lower level rice paddies.

The new crop of rice is planted in broad beds about 2 m wide, apparently these are seed beds. These are quite dry, with depressed drains rather than dykes between the beds. Very wet fields were at this time (July) being planted out to rice from these seed beds, Fig. 276 (142-5).



Alluvial  
The Coastal soils - Muiluk, Kwangchouwan, Luichou,

Pakhoi. The lowlying recent alluvial soils in this region occupy a considerable area, as is apparent from the map. At the time of the field work they were practically all planted to rice, covered with water, and consequently almost unavailable for study. Further, the roads of the region as far as possible avoid the rice lands, so that we saw a smaller proportion of the alluvial soils than of the uplands.

Between Muiluk and Wangpo. The alluvium is not all very deep, as a few granitic rocks were seen at the Wangpo river crossing. The soils along the branch road, north of the river, are apparently all a fine sandy loam, silt loam, or clay loam; grayish brown or brownish gray i.e. a fairly light texture and a not pronounced color--a rather typical alluvial soil. The soils along river banks are all micaceous, as would be expected from the nature of the headwater drainage. Between the two rivers the road runs most of the way along the dike, inside the dike nearly a half of the area is in excellent hemp, the rest in rice. Outside, to the south is a little hemp and a little rice, but not so good nor so much, because of lack of protection from floods.

Some of the alluvial soils are the result of direct river deposition, Figs. 276, 285, 306, 323, 324 (142-5; 144-4; 147-5; 149-9; 150-3), while others at the mouths of the rivers undoubtedly have been more or less influenced by sea-water, Figs. 277, 278 (142-6, 9). The great range of the tides in some localities, such as near Kwangchouwan, subjects a greater amount of soil material to effects of the salt water. Such different conditions of deposition would be shown in the texture and the nature of the material, as the soils being deposited from salt or brackish water are usually heavier and show chemical differences due to the effects of the salt.

Most of the valley alluvial soils are planted to rice, though occasionally, especially if the water be deep, matting rush is preferable.

While lime in some form is applied very extensively on rice fields located on the older, deeply weathered soils in the interior of the province, this is not the case on the recent alluvial soils. Near Luichou and elsewhere (146-8) broken coral and sea shells are burned to make building lime, but it is not applied to the alluvial soils, the reason being given that "it is too salty". The probable real reason is that the rice on these recent soils doesn't need lime.

LIMCHOU--PAKHOI--KUNGKWANG REGION

South of Limchou to Pakhoi, and east of Pakhoi, as well as east of Limchou, there are large areas of the brown upland Pakhoi sandy loam, and small bodies of the black valley Lankong series, which are described elsewhere in this paper.

Farther eastward from Limchou the hills are nearer the coast, and the shales and sandstones with quartz veins, appear thru the sandy loam Fig. 381 (165-2) making the soil a gravelly loam. Still farther eastward there are none of the Pakhoi series of soils, the region being a succession of hills and valleys, mostly hills. The road runs along the base of larger, higher hills, these having alluvial fans and slopes, the lower portions all being terraced Figs. 385-389 (165-10, 11, 12; 166-2, 3).

Apparently the hills running southwest to near Limchou are of the same general group of materials Fig. 379 (164-12). Southwest from Kungkwan the soil of a part of the lower slopes is replaced by dark bluish gray limestone with many quartz veins Fig. 391 (166-11). Here also, further toward the bay, are remnants of light reddish brown diluvial deposits, about 10m thick. Between Kungkwan and Onpo, northwest of the river, in places there very occasionally, appear in road cuts or stream banks, granite, red sandstone, and "red beds". Near Shankou



some limestone was noted exposed in the stream beds.  
It is believed <sup>these rocks</sup> ~~they~~ do not at all affect the soil, which seems to be all diluvial material.

As to alluvial soil, there is relatively very little anywhere between Onpo and Limchou. To the west of Limchou there is a large expanse of alluvial soils, but due to the floods during July '32 we were unable to examine these soils, Fig. 374, 375 (160-9; 161-8).

#### THE CHUMEN SERIES

The soils of this series are predominantly a brownish red in color, when moist sometimes a bright red. Often-times they are a darker color, a brown as near Hoihow, to a grayish brown or dark brownish gray at times, or even a chocolate brown as a moist hand sample. There are often no distinct horizon formations for some depth, other than the gradual change to a lighter color, a brighter red, with depth. Below about a meter there may be found at times a mass of small iron concretions, more or less cemented, and lying above the more or less weathered basalt parent material, Figs. 345, 346, 350 (153-12; 154-1, 6). This profile, residual from basalt on the sea bluff southeast of Chumen, shows the following profile Fig. 349 (154-5).

0--1 m brownish red clay loam

1--2 m cemented concretions

2--4 m and below, basalt

The texture of the surface soil is usually a clay loam. The soil may be a gravelly clay loam or loam in those places where the original surface soil has been eroded away, exposing some of the concretionary material, as south of Chumen, or north of Wushek. There is one atypical body of sandy loam soil near Meichen, (see below). The soil structure is usually very finely granular, and as near Chumen, makes a natural mulch on the surface.

The parent material seems to be entirely basalt, which lies in large flows, Figs. 347, 350 (154-3, 6), or more or less distinct cones, as south and west of Chekam. Near Hoihow the basalt appears to be younger, and is more in the form of lava flows, less deeply weathered, which also probably accounts for the less bright color of the soils there.

The topography of these soils is as a whole slightly irregular, being very gently undulating or one of slight hills and shallow valleys, or the slopes of low craters as near Chekam. Figs. 328-331, 333, 334, 346, 347, 351, 352 (150-12; 151-1, 2, 9; 152-10; 153-10, 11; 154-1 3, 9, 10). Near Hoihow the surface is distinctly irregular,

being that of lava flows, Figs. 414, 415 (171-11, 12). Southwest of Chekam there seem to be volcanic ashes under the soils, but it could not be determined whether or not they constituted the actual parent material of soils of this series. The most typical example of the soils of the Chumen series is at Chumen, the southernmost hsien of the Luichou peninsula. Basalt becomes more conspicuous, north of Wushek with rounded boulders scattered about, pickt off fields, and made into field and terrace walls, Fig. 331 (151-9). In road cuts near streams concentric weathering is very conspicuous and extensive. Weathered rock has the typical "murrum" appearance, as in India. Many iron concretions, make the soil appear a gravelly loam in places. On the surface of many of the boulders are heavy growths of lichens, but those stones at the soil surface or recently uncovered have a "tropical varnish" or limonite coating. In one place we saw cemented iron concretions making a massive "laterite" tho without the varnished tubules and channels that would make it completely typical. One hills, near Wushek town shows a profile typical of basalt flows. On the lower slopes, along the road, are some sandier soils, more like those north of the basaltic region.



Between the river and Meicheng the underlying rock is clearly a basalt. The reddish brown to brown clay loam, in place gravelly with concretions (Fe & Mn?), is underlain by a bright red clay loam to clay subsoil. Below this at about a meter is the bedrock. Where this is exposed it is often considerably weathered, Figs. 337, 338 (153-2, 3). Some exposures show also considerable quantities of cemented, thus massive, iron concretionary material, tho none with veins and channels. Some chunks of this concretionary material ~~are~~ used as a rough wall material, Fig. 340 (153-5). None has been cut into blocks as true laterite is used.

The soils of this series have not eroded much, distinctly less than the adjacent Pakhoi series from the unconsolidated sedimentary deposits.

These soils have a variable cover. In their typical locality there is a large tract of second growth forest, quite luxuriant, Fig. 354 (155-6). Farther north, Fig. 328 (150-12), and west of Chekam there is nothing but grass. The grasses seem to grow better on this soil than on the Pakhoi series.

The crops on the soils of this series are variable. Close about Chumen town there is a vigorous agriculture, Figs. 351, 352 (154-9, 10), comprising all the usual

upland crops: peanuts, cassava, sugar cane, sweet potatoes, cucurbits, upland rice (possibly only as seed beds for lowland planting). The condition of the crops is uniformly good, with a rich green color as if they had plenty of nitrogen. More distant, more than 1 to 2 km N. E. and W. from Chumen, where the land has been abandoned, there are remains of bunch grass cultivation, bamboo plantations, etc, Figs. 341, 342, 353 (153-6, 9; 155-5). Previously there was more extensive cultivation of sugar cane, Fig. 342 (153-9). Between Luichou and Yingli there are a number of recent plantations of pineapples which seem to be doing well, Figs. 329, 330 (151-1, 2). The northwestern body on the contrary, has nothing but grass.

The lighter, deeper phase of this series is found southeast of Meichen village, Chumen Hsien. This is a body of reddish brown sandy loam soil apparently not over a kilometer across, 20 to 30 meters higher than the most of the country about, rising with very gentle slopes Figs. 332-335 (152-9, 10, 11, 12). The soil judging from the road cut, Figs. 335, 336 (152-12; 153-1), and the surface appearance, is a sandy loam with a clay loam subsoil. It is strikingly without horizon development. A profile is as follows: Fig. 336 (153-1).

0--25 cm cultivated, grayish brown, potsherds.

25--250 cm reddish brown to brownish red sandy loam to heavy sandy loam (Pick handle about 42 cm long) Structure not conspicuous.

The crops are the usual upland ones of the region, Figs. 332, 333, 334, 339 (152-9, 10, 11; 153-4).

In slight depressions and small valleys in this soil series, there are dark grayish brown soils planted to upland crops, Figs. 343, 344 (153-10, 11), while in the lowest places some rice is grown on quite darker colored soils, perhaps to be correlated with the Laukong series.

#### THE PAKHOI SERIES

As shown in Figs. 279, 281, 282, 283, 294, 303, 320, 321, 364, 367, 404, 405, 413 (142-11; 143-2, 3, 4; 145-10; 146-10; 148-10, 11; 158-6, 11; 168-4, 5; 171-10). This brown sandy loam soil occupies vast upland plains which are for the most part uncultivated.

In color the soil varies from a brownish red to a reddish brown, or at times a greyish brown. Near Pakhoi the real surface soil is usually a brown or greyish brown rather than having a reddish tinge. The subsoil, as exposed in cuts and by erosion, is a brighter brown and in deeper lying portions a reddish brown or even a brownish red.

The texture is usually a sandy loam, at times varying to a coarse sandy loam, as at Chekam and Hoihow, or a fine sandy loam, as in places near Muiluk. The uppermost meter or more of soil material is without conspicuous



horizon development. There is often little or no change down to a meter or more. In the deeper soil material there are a great many variations, some of which are certainly developmental horizons, while others are the result of differences in the original strata as deposited. Some of the following profiles will illustrate these differences, Fig. 288 (145-3), near Chekam, Kwangchouwan shows:

- 0 - 5±cm - iron concretions
- 5 - 200±cm - brown, slightly mottled, reddish and whitish
- 200 - 350±cm - more "shaley"

The eroded bank of a ravine, Fig. 293 (145-8) shows the following horizons:

- 0 - 50 cm - sandy loam
- 50 - 55 cm - iron cemented quartz sand
- 55 - 80 cm - sandy loam
- 80 - 90 cm - iron cemented quartz grains
- 90 - 140 cm - splotched red and yellow coarse sandy loam, marked by the pick.
- 140-- 150 cm - iron cemented material in thin plates
- 150 and downwards, a light bluish clay with some red markings

In this locality other variations are shown in Figs. 295-299 (145-11, 12; 146-1, 2, 3). An example of very deep material without pronounced horizons is shown in Fig. 309 (147-9), where there is the following profile.

0 - 4 m - reddish brown sandy loam

4 - 7 m - yellow and blue mottled

7 - 8 m - light bluish with red splotches.

The floor of this ravine is a hardpan of thin iron cemented material. Another profile which indicates that the horizons are largely the result of the effects of the original bedding material is shown in Fig. 312 (148-1). Note also Fig. 317 (148-7).

As would be expected in a humid subtropical region of high rainfall, in some cases there is definite a tendency toward the development of a typical white and red mottling, as is associated with some other tropical soils, as shown by the following profile, Fig. 361 (158-2):

0 - 2 m - reddish brown sandy loam

2 - 5 m - purplish and whitish mottled clay.

This is near Kaota Village, Pakhoi.

As a whole, this series shows only a very slight development of structure. Near Muiluk and Chekam it exhibits very faint and coarse columnar tendency. Elsewhere there is no evident structural development, except in the subsoil materials where there has been the hardpan formation, as described <sup>above</sup> ~~in~~ Fig. 293 (145-8) ~~there~~.

The parent material in all cases seems to be unconsolidated sedimentary shallow water deposits. The slope of the beds and at times the characteristic cross bedding, Fig. 310, 312 (147-10, 12), points to such delta deposits. This is substantiated by a considerable range in size of materials, which vary from very fine silt or clay to quartzitic gravels and coarse sand.

This series of soils as shown by the map, occupies a large part of the Luichou peninsula. As the above data and illustrations indicate, the Pakhoi series is most certainly neither of volcanic material nor of volcanic material nor of volcanic origin. It is probably of Pleistocene age, as given on the geologic map of Liang Kwang, and the material has come from the large bodies of granites and other rocks to the north.

The topography of these upland plains is from very nearly flat to slightly undulating, as about Pakhoi, or more rolling, as near Limchou. East of Pakhoi there are some depressions which appear to be entrenched meanders or in other cases a succession of filled lagoons between a series of barrier beaches formed before the present elevation of the shore line. Near Ngchen the topography seems rather more dunelike



The present topography has been very greatly modified by the serious erosion which has occurred in many places in the soils of these series. Figs. 290-293, 295-301, 309-311, 315-320, 322, 327, 369-371, 398, 401, 411-413 (145-5, 6, 7, 8, 11, 12; 146-1, 2, 3, 4, 5; 147-9, 10, 11; 148-3, 6, 7, 8, 9, 10, 12; 150-11; 159-7, 8, 9; 167-10; 168-2; 171-8, 9, 10). The more serious examples thus seem to be near Chekam and Luichou. Near Pakhoi there is some bad erosion, but apparently as indicated by the size of the pine trees in the ravines, it is not proceeding very fast, Figs. 369, 370 (159-7, 8). As is often the case erosion is apt to develop along trails or cart tracks.

As is apparent from a number of the illustrations, Figs. 279, 303, 320, 321, 326, 404 (142-11; 146-10; 148-10, 11; 150-10; 168-5), the soil is generally very scantily covered by grass or other natural vegetation, indicating a very low average fertility. Consequently the crops grown on this soil are few and are all relatively low in value. Vast expanses, in spite of their favorable topography, are entirely uncultivated. Nearer some towns where there are sources of local fertilizers and better markets for produce, there is a considerable agricultural utilization, growing the usual upland crops: sweet potatoes, sesamum, peanuts, with at times some sugar cane or truck

crops. One of the more extensive crops is pine. These trees seem to do fairly well on these soils, Figs. 363, 368, 372, 380 (158-5, 12; 159-11, 165-1), as would be expected from the well known ability of pine to grow on very poor soils.

Organic matter combined with pond or sea mud is used wherever possible to fertilize the crops on these soils.

There are a number of variants of this series found in various places, particularly where the elevation is slightly lower. With more moisture the soil is greyer, and at times where there is enough water, planted to rice, as near Fort Bayard and near Cheng Yue, north of Luichou, and at Shekhong, Fig. 403 (168-4). Near Muiluk there are a number of low elevations of gravelly loam underlain by clay with quartz grains, whitish splotched with red, Fig. 280 (142-12). In other places in this locality this gravelly material just comes up level with the general surface of the soils, as South or South-west of Muiluk. In such cases the soils are marked by iron concretions on the surface.

### THE LANKONG SERIES

In a number of cases particularly in slight depressions which collect an extra amount of rainfall and facilitate its percolation down through the soil mass, there develop very black soils underlain by a relatively white subsoil.

This is, of course, the general type of profile known as a podzol which develops where a large amount of organic matter accumulates on or in the surface soil and the organic acid material leaching downward bleaches out the lower horizon. These conditions have been observed especially in depressions in the upland brown sandy loams of the Pakhoi series, Fig. 362 (158-4), of an eroding stream bank, about half way between Pakhoi and Limchou, shows the following profile:

- 0 - 50 cm - black soil
- 50 - 100 cm - grey and reddish subsoil
- 100 cm and below - bluish white and red pink  
mottled substratum material

Fig. 362 (158-4), shows that at the present time the soils material is eroding very badly. This black soil of course developed before the present erosion cycle started, for now there is excessive drainage in such localities.

A more intense development of the profile is shown in Fig. 373 (160-1), which has the following horizons:



0 - 18 cm - black soil. The face of the exposure, however, as shown in the photograph, is covered with white substratum material because of excavating the white material below

18 - 100 cm: black material, apparently largely decomposed organic matter

100 cm and down - a white slightly sandy clay only a few centimeters of this horizon are visible above the water

It is this substratum material which is excavated for the making of pottery. On the soil surface are about 20 cm of mixed white and black soil, spoil resulting from the excavation. The general region in which these black valley soils occur is shown in 158-11.

An immature form of this type of soil development is shown in Fig. 303-305 (146-10, 11, 12), where in a depression in an upland plain near Luichou water had accumulated, giving the sandy loam soil a dark grey to greyish brown color and had caused the bleaching of the substratum material to form a white clay material, which had been excavated for pottery.

In the bottoms of the narrower slightly deeper valleys, usually quite close to small streams, a great many other exposures were also seen showing profiles of more or less developed similar black soil material. The soil is very definitely black in color and usually from 25 to 40 cm deep.

As a whole these soils have no agronomic importance, though at times they form a part of rice fields. At other times, as west of Tamshui, they have been buried in the process of terrace formation, as observed in some recent road cuts.

Similar soil profiles have developed under artificial soil conditions as on level flooded terraces, Fig. 202 (131-6), in the Chienpai mountains shows a grey soil about 30 cm deep, underlain by an almost white subsoil.

#### SEA BEACH AND SAND DUNES

In a number of places along the coast are accumulations of windblown sand, driven back from the sea beach. Around Ngcheng, Muiluk, at Wushek and near Pakhoi, and at Hoihou, Hainan, there are such sand dunes, Figs. 336, 376-378, 408 (144-10, 164-1, 2, 163-10, 171-5). As a whole, however, dune sand deposits are relatively minor in area and importance. This is because the coasts of Kwangtung are usually either steep and rocky or else the rivers, transporting mainly very fine materials, make mud deposits rather than sand accumulations.

These sands and sand dunes are of light brown or nearly white, fine sand which is apt to drift a good deal in times of high wind. Around Wushek there is some endeavor to grow seed bed rice on these very light sands,

and near Ngcheng some of the lower sandy soils are cultivated to rice, but not very successfully. Near Wushek Melia and Hibiscus tiliaceous trees grow quite well.

Doubtless the best use of these sands would be to plant them to Casuarina, which produces very good fire wood, as well as timber of fair quality. Near Hoihou lowland rice is grown in the depressions between the old barrier beaches of sand.

Near Wushek and near Muiluk some of these sandy areas are excavated and used for evaporating sea water to obtain salt.

### FERTILIZERS

The preparation and use of composts is very general, pond mud or soil being crushed, sifted, and mixed with ashes, night soil, farm yard manure, and lime, Fig. 382 (165-4). The objectionable effects of mixing freshly slaked lime with these substances was well demonstrated at Shekhong, where there was a very noticeable odor of ammonia in the air, meaning a loss of the most needed element, nitrogen, Figs. 399, 400 (167-11, 12). In order to secure effective distribution of this compost, which is so limited in quantity, it is usually applied to the rice seed beds, <sup>Fig. 383</sup> (165-6), just before removing the seedlings.



The seedlings are then taken up as sods, with the compost on the surface, and the planting done in such a way that there is a portion of the compost about each of the bunches of rice plants after they are set out, Fig. 384 (165-7). This insures the most rapid plant nutrient availability for the young rice plants.

In other places grass sod from the hillsides is scraped up, with a considerable proportion of soil, and after drying this is burned. This soil and ashes mixture is later used as fertilizer on the rice fields, Fig. 386 (165-11).

Liquid night soil is often transported to the fields in large tubs or casks on carts, and then distributed in the fields by buckets, using dippers to apply the material to the hills of upland crops, Fig. 396, 397 (167-7, 9).

Lime ~~may~~ is also often ~~be~~ applied directly to the rice fields, after plowing, when working the soil with the harrow, before planting.

#### SEA MUD

In Central and South China there is a wide-spread practice of using the mud from streams, ponds or canals for application to cultivated fields as a manure or fertilizer. In the whole region from Tungchen south to Kochou, Muiluk, and southwest, there was noted the common practice

of drying, crushing and mixing pond mud with organic waste materials, letting this cure under thatched shelters, and some months later applying this to the rice fields, especially the seed beds, Figs. 236, 257, 258, 382 (136-8; 139-5, 6; 165-4).

Near Kaota village, Pakhoi, is the only place, however, where there has been observed the use of marine mud from the bottom of the bay for preparing compost for fertilizing agricultural soils. At times of very low tide, the mud from the bottom of Pakhoi Bay is hauled out in bullock carts and placed in heaps on the upper beach to dry, Figs. 357, 358 (157-2, 7). This mud may vary a great deal in texture, being anything from a coarse sandy loam to a silty clay loam or clay, depending upon the place in the bay from which it was taken and the nearness and size of the streams flowing into the bay. The quantity of sea-shells also varies a great deal. Because of the material having been deposited under water, it is light bluish in color. The drying of the mud on the upper beach undoubtedly gives a chance for the excess salt to drain out and be washed away from the mud, although the farmers give as their reason for storing it here that there is not room enough for it on the uplands. Later the material is broken up and carried or hauled up onto the uplands onto

special drying and mixing floors where the mud is further broken up with stone rollers, mixed with manure and any other available organic matter, covered with thatch to keep off the rain, allowed to ripen for a time, one or more months, and then applied to the fields. A heap of sea mud on the mixing floor is seen in Fig. 356 (156-6). In the foreground is a long thin stone roller, 20 x 120 cm, used for crushing up the mud after drying. On the horizon are the bare mud flats, of Pakhoi bay at time of very low tide. Fig. 355 (156-4), shows two heaps of compost mixed with manure and between them lie two other heaps of lighter color sea mud, as yet uncombined with organic matter. The actual effect of the sea mud itself is unknown. The shells in it undoubtedly supply considerable amounts of lime to the soils of a region where there is little lime in the soil and where it must be quite expensive to purchase lime. Also the sea mud serves to dilute the organic matter, and secure a more effective distribution. It may also be that even after leaching and exposure to the rain the mud still contains an appreciable amount of salt which may increase the available plant food by base exchange effects in the soil. Chemical analyses of representative samples of mud should be made in order to get a better understanding of what its effects really are.



As there are relatively few ponds in the region back of Pakhoi, this sea mud is transported for a number of kilometers in from the coast. Where the distance from the coast is too great, ordinary surface soil from between young pine trees has in places been taken and used to mix with manure or other organic matter for fertilizing the fields.

It is a common practice to use small cubes of the dry sea mud as a potting soil for plants.

#### SOILS ALONG THE CANTON-SHIUCHOU RAILWAY

Leaving Canton the railway runs through flat lowland country where there are grown, besides rice, considerable areas of other aquatic plants such as lotus. Between Shui Ping and Tai Long Stations, in order to make a greater area of rice fields, considerable quantities of excess soil have been heaped up making the general surface quite uneven. In a good many cases the heaps have been used for grave sites. North of Kwong Chuen there are some low hills and some of the soil is used for upland crops, although a considerable amount of higher material is uncultivated, Fig. 418 (172-3). The soils as a whole average greyish brown in color. Between Kwak Tong and Sun Kai Stations the soil in the rice fields appears browner, but it is

not the recent river alluvium, but is more sloping, having been developed from browner hill material. Some fields of hemp are seen in addition to rice, and pines are more common, Fig. 419 (172-4). North of Sun Kai Station the stream is aggrading. The rice land is quite flat. The upland soils are more of a reddish-brown color. North of Lok Tung Station the railway passes from the southern rice plain through a line of bare greyish hills and out on to another plain to the north-west, Figs. 506-508 (183-10, 11, 12). North of Quien Tien Station the soil of the rice fields is a little yellowish grey to light brownish grey, the subsoil being almost white, Fig. 420 (172-5). ~~There are many small streams.~~ At times they vary from a light greyish brown to brownish grey. The topography is that of aggrading streams coming out on the plain from the foot hills, Fig. 421 (172-6). The hills as shown are of granitic material, very deeply weathered, and erode seriously. The cover of pines is often very scant. Compare also, Figs. 504, 505 (183-7 8), where there are seen hills with poor cover, and in the other case the rice fields are being endangered by overwash.

Near Ng Chan An, as apparent in Fig. 503 (183-6), there are aggrading streams flowing from the eroding hills, with some rice fields already covered by the overwash. The hills in the distance are high, not well wooded and yet do not appear to be eroding seriously, possibly because of different material. North of Ng Chan An the granitic hills have a light yellowish brown soil with a subsoil in places slightly reddish. Where the hills are bare they are eroding a good deal. Another aggrading stream is shown in Fig. 502 (183-5). In this particular locality there are some good trees around the village, but as a whole the forest cover is poor. Compare also, Fig. 422 (172-7), where there are numerous pines, and some fern growing on the hill has been cut for fuel. On this hill are also some small Cunninghamia. The erosion from the hills has resulted in an overwash, damaging the fields in the foreground.

Stream erosion and a soil profile of alluvial soils is shown in Fig. 501 (183-4). North of Yin Chiu Station the rice continues on the lowlands, but with the more gentle hill slopes terraced and planted to sugar cane. Fig. 423 (172-8). The soil in this case is from granites and is from light yellowish brown to light greyish brown.



In another locality the rice is on terraces further up the slope. In this case the soil, 20 - 30 cm deep, is grey. Below it is a light yellowish grey. In the distance higher up on the hill slopes the soil is an irregular red. In another case, Fig. 500 (183-2), the hills are red, eroding very badly with only some pines and low grass.

Just South of Yuen Tan Station, Fig. 499 (183-1), there is less rice cultivated, but more upland crops. North of Yuen Tan Station, the topography is one more of foot hills with higher hills in the distance. The hills are of reddish material, particularly the subsoil, though it is uncertain as to whether red beds, or granites, or possibly schistose materials predominate. The surface soils seem to be about the same as elsewhere. There is, however, practically no recent alluvial soil, the lower hills extending out to the river, Fig. 424 (172-9).

South of Par Kong Hou, granite rocks continue to be seen and the soils resulting from these rocks where deeply weathered are apparently the ones that erode the worst. In this locality the topography is hilly with a small amount of light colored alluvial non-irrigated soil.

At Par Kong Hou there is quite a plain of rice fields with light brown alluvial soils, Fig. 497 (182-9). Bamboo grows about the lower hill slopes. Compare also, Fig. 498 (182-10), just south of the last. The hill soils shown are quite red. Near Wang Shek Station there is again more agricultural land on the valley floor and lower slopes of the hills. Rice, as usual, is the predominating crop. Between Wang Shek and Lai Tung the hills are lower, apparently with more granites, but no agricultural land, except bits of terraces of sandy loam near the river. Bamboo grows on almost all of the available land, Fig. 496 (182-8). In some places across the river numerous land slides were noted. Note also, Figs. 459, 426 (182-7, 172-11). Near Lai Tung are the last of the granite rocks toward the North. In this locality are the conditions illustrated in Figs. 425, 426 (172-10, 11), where the river valley is rather narrow, but with here and there considerable expanses of rice, hemp and lighter alluvial soils with old terraces running quite high up the hill slopes. Near Lim Kong Hou, Figs. 427, 494 (172-12; 182-6), there is practically no agricultural land, the more or less steep hill slopes extending almost directly down to the water's edge, the railway line being cut into the

steep hill slopes. The same condition extends most of the way north to Bo Lo Hun, Fig. 493 (182-5). Around Bo Lo Hun appear limestones, and there is a considerable extent of alluvial plain. Near the Station a large expanse of alluvial land is planted to bamboo. North of Bo Lo Hun, again there is more rice, with the steep limestone hills rising up almost directly from the plain, Fig. 429 (173-2). In some of the rice fields in this locality the straw is burned directly in the fields after threshing, Fig. 489 (182-1). Note also the relation of bamboo groves to rice, Fig. 490 (182-2).

Near Ying Tak Station a great deal of lime was seen being applied liberally to rice fields where the plants had been transplanted about three or four weeks previously. After broadcasting, the lime was being well worked into the soil. The soils in this locality are alluvial and seem very similar to those far to the <sup>south-</sup>west, about Shun Yü and Kouhou. Certainly these soils are not the same as the alluvial soils farther North, beyond the narrow canyon around Tai Hong Hao Station. Just South of Ho Tao Station, Fig. 488 (181-12), many rice fields were being limed. Farmyard manure mixed with large amounts of straw was also being applied to rice fields planted out three or four weeks previously. The lime was being



mixed thoroughly with the soil by raking. In this locality all the cultivated soil seems to be alluvial although it is apparently somewhat higher and is certainly browner than that further north. Fig. 487 (181-11), taken north of Ho Tau Station, shows a flood plain of light brown to brown soil with a field surface 10-15 m above the river level.

South of Sha Hou Station the rice soils are more irregular in topography, Fig. 486 (181-10). The soils of the older hills in this locality are a brownish red about 1 m deep, underlain by a stony layer. In general about Sha Hou the soils are mostly light brown and even the lowland rice soils are apparently not so grey as the alluvial soils near Canton. The country on toward the North has less limestone. There is little agricultural land, with the river valley for a short distance being very narrow with no agricultural land, Figs. 484, 485 (181-9, 8). Here again a great many of the rice fields are being limed.

Around Tai Hong Hao there is more agricultural land, Fig. 483 (181-7). The soils are reddish brown with a relatively fresh exposure showing no appreciable horizon differences. The surface of rice field soils is light brownish grey. Toward the North there is more rice on

low terraces, Fig. 482 (181-6). Other conditions are shown in Fig. 430 (173-3), where most of the crops are non-irrigated.

In another locality, Fig. 431 (173-4), lowland rice is grown where possible, while those fields which are unirrigable are idle. This view shows another case of lowland rice fields being limed. Just South of Wushek Station the hill soil in a railway cut showed a very bright red color, while the alluvial soil in this locality is a light brown, Fig. 482 (181-6). The conditions north of Wu Shek are shown in Fig. 481 (181-5), and a little further North, where the limestone is again noted, there is brown soil. Another condition is shown in Fig. 409 (171-6), where there are the same wooded slopes, but with the distant hills quite grassy. Still further North, as shown in Fig. 478 (181-2), some of the upper soil seems to be reddish brown from red beds and preserves its color even though used for irrigated rice. South-west of Maba Station the country opens out more, the valley is broader and the hills are not so high, Figs. 433, 434, 435 (173-7, 8, 9). Near Maba Station itself there are some limestone bluffs which are quite conspicuous, Figs. 435, 477 (181-1 Compare also 173-9). The soils as a whole seem to be a yellowish brown diluvial material. In places in cuts

there is a little mottled red and white material, presumably a subsoil. North of Maba Station, toward Shiu-chou, near the Forestry Experiment Station, the soil is brown to yellowish brown in the fields and railway cuts. It seems to be as a whole very uniform, although in places the soil is redder and appearing more like a soil from limestone, although in this locality no limestone itself was seen from the train. Near here some of the railway cuts show considerable tropical mottling of the subsoil. Some of the lower rolling hill slopes of brownish red sandy and gravelly deposits look something like the diluvial deposits south and south-west of Canton.



Table of distances along the Canton--Shiuchou Railway.

Distances from Canton km	Stations	Distances from Shiuchou km	(distances measured in straight lines from the two termini)
	Canton	190	
9	Shui Ping	182	
11	Tai Long	179	
18	Kwong Chuen	173	
24	Kwak Tong	167	
29	Sun Kai	164	
33	Lok Tung	160	
42	Quien Tien	154	
54	Ng Chan An	144	
61	Yin Chiu	136	
65	Yuen Tan	130	
71	Par Kong Hou	123	
80	Wang Shek	112	
91	Lai Tung	102	
104	Lim Kong Hou	87	
109	Bo Lo Hun	80	
115	Ying Tak	75	
127	Ho Tao	62	
147	Sha Hou	41	
162	Tai Hong Hao	27	
164	Wu Shek	25	
177	Maba	10	
190	Shuikwan	0	

### SOILS OF THE SHIUCHOU REGION

The upland soils of this region have been derived from both sedimentary and metamorphosed materials of many sorts: limestones, shales, sandstones, schists and a great deal of "red bed" material. These formations have been very extensively deformed. The provincial geological map indicates something of the complexity of the formations.

The soils are far from mature, being shallow and often stony or gravelly, Figs. 443, 462, 464 (174-11, 177-10, 178-1). Except very locally the horizons are not well developed, Fig. 441 (174-8). The subsoils are often mottled in color, but there is no indication of maturity of profile, Fig. 462 (177-10). This relative immaturity of development is very different from the conditions that prevail nearer the sea coast. The differences are due to one or more of the following features:

1. Less rainfall.
2. Lower temperatures.

There is not much difference in steepness of slope and as for types of rocks and their rate of weathering, the ones that are found here in the North undoubtedly would weather at least as rapidly as the granitic rocks further to the South, along the railway between Canton and Shiuchou, and along the coast at Hong Kong and

Chungshanhsien. The fresh railway cuts to the North-west of Shiuchou, Figs. 438, 441, 448, 451, 453 (174-4, 8; 175-4; 176-3, 9), and the recent highway cuttings to the North-east of the city on the Namyung road, Fig. 472 (179-6), offer excellent opportunities for a study of the varying profile conditions. In one locality in particular, near Laiputao, Fig. 451 (176-3), where the new railway cut crosses low hills and slight depressions, there are shown marked differences in the soil profile. The soil of the elevations is reddish brown while in the hollows the thin surface soil is a quite dark grey with an almost white subsoil.

In the Shiuchou district there are at least the following quite distinct groups of upland soils: 1. Bright red to purplish red loams, clay loams or clays. These soils are on low or higher hills and are shallow, hilly and eroding somewhat, especially to the North-east. No 174-8, in addition to showing a very slight horizon differentiation, shows distinct irregularity of the deeper rock material. The soil in this case is brown to reddish brown and moderately finely granular. The general topography of this red or purplish soil is well shown in Figs. 441-A, 444-446, 457, 461 (174-9, 12; 175-1, 2; and 177-5,9). In a road cut, Fig. 443 (174-11), is shown the following profile:



2½ m of purplish red clay, grading into a clay; gravels may be noted at the base of the cut. In the small valleys or depression in these soils are rice fields. Although these rice soils are undoubtedly derived from the purplish red material of the locality, the color of the soils has for the most part been changed by submersion and the other agronomic practices necessary for rice production. An exception, where the soil is still purplish red, is shown in Fig. 463 (177-11).

The general form of hills of red-bed material along the river is shown in, Figs. 465, 466, 467 (178-2, 3, 4), where the upper terraces and the low hills are of this material. In places close to the river are some alluvial soils. The sky-line shows the rugged character of some of the hills to the North-east of Shiuchou.

2. Brown or greyish thin surface soils lying on light brownish red silt loam or clay loam. These are local soils, being residual from limestone which is not very common in the region. One of the few limestone hills noted is shown at the right in, Fig. 437 (174-3). In one case to the north-west of Shiuchou is a soil on limestone, which is probably derived from non-limestone sources, or else the limestone from which the soil has been weathered was more than usually impure, so that the soil is rather abnormal.

In this case the soil is light brown to yellowish brown in color, Fig. 455 (176-12).

3. Grey to dark grey soils from coal-bearing formations. This is a very limited sort of soil and is likely the result of much digging over of the soil in search of coal. One hill to the north-east of the city in the general region of, Fig. 459 (177-7), gave indications of the whole slope having previously been mined over, although when we were there the surface was fully covered by grass.

4. The remaining geological formations give rise to by far the greater portion of the upland soils. These soils are greyish brown to light or medium brown, and there are wide variations between the gentler and steeper slopes of the mountains. The horizon development is extremely slight. Most of the subsoils are light brown to brown. Near the coal mine North-east of Shiuchou there is, Fig. 462 (177-10), the following profile:

1±m browish or light yellowish brown clay loam

1±m and below ~~1±m~~ mottled clay loam to clay.

The pick marks the transition between the two horizons. Another road-side profile, Fig. 464 (178-1), shows:

0 - 40 to 60±cm a light brown (moist color), light yellowish brown (field color), typical of these soils. The texture is a silt loam

40 to 60±cm and below: the subsoil is a light clay loam. The plant cover is pine, Cunninghamia, grass, and ferns.

An example of a very deeply weathered profile in shales and fine sandstones is shown in, Fig. 438 (174-4). The soil is brown and only about 25 cm deep. The deeper material shows some purple streaks in addition to the browns and yellows.

A recent railway cut exposes a profile as shown in Fig. 448 (175-4).

0 - 10 or 20±cm: brownish grey surface soil

10 or 20±cm to 300-600 cms: a brown subsoil,  
apparently a clay loam.

The underlying rock material is very irregular in its depth below the surface.

The hills soils shown in Figs. 459, 460, 468 (177-7, 8; 178-5) illustrate the general topographic conditions of this soil group. About Taikiu and eastward, the soils are light yellowish brown (brownish grey or brown when moist), about 10 cm deep, hilly, covered with grass or trees and not eroding notably.

#### THE OLDER ALLUVIAL SOILS

The older alluvial soils are light brown, with a greyish brown surface. The texture is a clay loam, at least in part, as might be expected in such deposits. In places there are gravel beds below the surface soil. This group of soils is quite limited and irregular in



its location, at times it is hard to differentiate it from the more recent alluvial soils and, as around Laiputao, Figs. 450, 451 (176-2, 3), from some of the lower lying residual soils.

A rather different profile in the general locality of the red-beds is shown in Fig. 442 (174-10), which is a section of a rather old soil exposed on the roadside:

0 -  $1\frac{1}{2}$  m a brown light clay loam grading gradually to a reddish brown clay loam below.

The structure shows a slightly columnar form. The soil cover is a good growth of grass.

#### THE RECENT ALLUVIAL SOILS

Along the large streams are scattered bodies, Figs. 449, 450, 465, 466, 467 (176-1, 2; 178-2, 3, 4), of recent alluvial soils, light greyish brown, light brownish grey or at times, as near Laiputao, light yellowish brown. When moist these soils are for the most part a light medium brown. The textures vary from a silt loam or fine sandy loam near the rivers to heavier textures and slightly lower elevation further back from the stream banks. Because of their relatively very recent formation these soils show no noticeable horizon differentiations though of course there are stratification differences. The soil in the foreground of 174-3 belongs to this group, as also

does, Fig. 456 (177-4). These alluvial soils lie from 5 to 10 m above the August 1933, level of the rivers.

The main crops raised on these soils are peanuts and beans. Especially along the South-west side of the West Fork of the river there are considerable areas of sugar cane, Figs. 439, 449, 452 (174-5; 176-1, 4).

On some of the lower heavier soil types of this group, further back from the stream, rice is grown. This group of recent alluvial soils is found here and there along both banks of the two forks of the river above Shiuchou at least as far as Laiputao in the north-west and Chihing in the north-east, Fig. 475 (179-11), near Chihing. This same group is the one seen from the train for a considerable distance south of Shiuchou.

#### RIVERWASH

Here and there along the rivers are found considerable quantities of sand and gravel riverwash, Figs. 436, 449, 465, 468, 473, 474 (173-10; 176-1; 178-2, 3, 4; 179-7, 8).

#### RICE SOILS

The soils on which lowland rice is cultivated, due to flooding for long periods each year, are usually colored a mottled brownish grey to a dark bluish grey or even dark

grey. In addition to lime, Figs. 440, 441-A (174-7, 9), there is also a good deal of organic matter added. In Fig. 447 (175-3), the soil is a bluish grey clay loam. Due to the <sup>red-bed parent material,</sup> Fig. 463 (177-11), is a purplish red soil even though it is flooded and planted to rice. Similar purplish red soils were noted near Taikiu. Apparently even under sub-aqueous cultivation this red color can persist for many years.

#### ORGANIC MATTER ADDED TO RICE SOILS

In various localities near Shiuchou all the rice straw from the first crop of the year is treaded into the mud between the rows of young rice plants of the second crop. This operation is carried out at the same time that the lime is added to the fields, that is, from three to four weeks after transplanting the seedling rice. Figs. 447, 441-A, 463 (175-3; 174-9, 177-11). The farmers say that this treatment with straw improves the physical condition of the soil. The straw from the second or fall crop is fed to the cattle or used for fuel rather than being added to the soil. There is, however, during the winter in the fields, considerable weed growth at least a part of which becomes incorporated with the soil before the planting of the first crop of the year. Farther out north-east from Shiuchou in some localities, apparently



all the rice straw from the first crop is burned, Fig. 469 (178-7), and only the ashes are added to the soil of the rice fields to fertilize the second crop. Lime is very generally applied to both crops of rice. The farmer of Fig. 463 (177-11), reports using as much as 2 piculs of lime per mou (2 metric tons @ Ha) per crop. He pays about \$1.70 per picul (\$27 @ ton) delivered at the field. He reports an yield of about  $2\frac{1}{2}$  piculs rice per mou per crop (40 piculs @ Ha @ crop). In some places farmyard manure is also reported to be used as fertilizer.

#### EROSION IN THE SHIUCHOU REGION.

Apparently soil erosion is not yet a serious problem, perhaps because of less population pressure on the country. That the soil materials erode when exposed is well shown in Fig. 438 (174-4), and they also erode under other conditions, particularly the red-bed material as shown in Fig. 453 (176-9). However, the erosion surface may at times become grassed over, obviously retarding the erosion, Fig. 454 (176-10). Erosion was noted on a few hills some kilometers distant from the East Fork of the river, as well as in the few places along the West Fork. Land slides were seen in a few places, but there are neither many of them nor are they large. These slides are probably associated with schistose materials as in the new .

railway cuts to the North-west of Shiuchou.

CHEUNG MUK TU - WAICHOU, SOUTH-EAST OF THE EAST RIVER.

The topography of the region is that of a drowned valley, with the flat rice land coming quite close to the foot of the hills; while there are some small valleys between the hills, and there are rice fields on the lower slopes of some of the hills.

The soils of the hills are yellowish brown, greyer at the surface, as apparent in Figs. 509-512, 514 (184-4, 5, 6, 7, 9). The slopes are quite steep and the surface soil erodes seriously. The profile of the rice fields where seen showed a grey, quite thin horizon, underlain by whitish soil with red splotches. An excellent profile is seen in, Fig. 536 (186-12), at the Chingkong bus station where a drainage ditch discharging into a stream had caused considerable erosion. The colors are as follows:

- 0 - 40±cm - yellowish grey soil
- 40 - 50±cm - a transition stone
- 50±cm and downwards - white splotched with red.

In places, probably where they are underlain by red beds, the color of the hill soils is more of a reddish brown. As a whole, the hill soils are quite shallow and in a number of places quite gravelly because of the fragments of the underlying rock. At Cheung Muk Tu, a number

of the hills, even the higher steep ones, are terraced and planted to fruit of many sorts, Figs. 581-584, 587, 588 (191-11, 12; 192-1, 2, 5, 6). Where these terraces are not carefully maintained, erosion is becoming severe, although it has not yet developed deep ravines, Fig. 584 (192-1). To reduce erosion various forms of terraces for upland crops are used. Note Figs. 588-590 (192-6, 7, 9).

A profile of the soil on rather deeply weathered red beds at Cheung Muktau Station is shown in Fig. 592 (192-12). The surface soil is brownish, while deeper the color becomes browner and then redder, with purplish and brownish weathered rock toward the bottom. This exposure is about 4 meters deep.

#### WAICHOU - PINGSHAN

East of Waichou there is between the two branches of the river a plain several kilometers across, with a greyish brown alluvial light silt loam soil. In places are red beds and other formations, with rocks just appearing at the soil surface. East of the plain near Maon village the low hills come toward the South, making a number of smaller valleys, Figs. 515-517 (185-1, 2, 3). A good deal of this soil is uncultivated, it is not known for what reason, as there seem to be no obvious defects



in the soil itself nor in its position. The low hills in this locality and East of Maon have a yellowish brown shallow soil which is almost entirely uncultivated, as in Fig. 515 (185-1). There are few plantings of pine trees on some of the hills. Near Pingtam there is more alluvial fine sandy loam. This is planted to sweet potatoes and other upland crops. Fig. 518 (185-4) shows a stream bank cut in this material, exposing a light greyish brown fine sandy loam.

East of Pingtam, for several kilometers, the road passes through a succession of low hills of very deeply weathered granitic material, Fig. 532, 535 (186-8, 11). As is apparent in Figs. 533-535 (186-9, 10, 11), the erosion has been extensive and the hills for the most part carry no cover at all of vegetation. Where any of the surface soil is remaining it is grey. The subsoil in some places shows conspicuous mottling. Gradually toward the south-east and nearer the river, Figs. 530, 531 (186-6 7), the elevation of these older higher soils decreases and the slopes merge with the plains, where some upland crops, such as sweet potatoes and peanuts, as well as lowland rice, are grown.

PINGSHAN - NIMSHAN

Between these places the topography is hilly to mountainous with some relatively flat valley floors with rice fields, Figs. 521-524 (185-8, 9, 10, 11). For most of the distance the rocks seem to be a deeply weathered granitic material. The soils as a whole are greyish brown on the slopes with brighter to red subsoils. The relatively large amount of quartz grains gives the impression that the soils are sandy. At times these soils erode very badly, as in Fig. 526 (186-1), where there are a number of ravines about 30 m deep, presumably developed from the original terracing of the slopes. The steep hills and upper slopes have yellowish brown stony soils, Fig. 527 (186-2). Near Nimshan there are lower hills with soils apparently very deeply leached and which are now not cultivated, Figs. 526-529 (186-1, 2, 3, 4).

The rice land soils and garden plots are grey to dark grey, the darker color probably being due to fertilization. Near Nimshan the use of lime on the rice fields seems to be very general. Sea-shells are burned to provide the lime which is applied at the rate of between 20 to 40 chin per mou (190 - 380 kg @ Ha) per crop. Compost fertilizer, as shown being prepared at Pingshan, Fig. 520 (185-7), is said to be used in quantity on the rice fields

either before or after transplanting. Ammonium sulphate is thought to be too expensive, moreover the farmers believe that it will make trouble after a few years, tho as usual there was no evidence obtained.

WAICHOU - TAMSHUI

South from the Chungkong bus station, the country is a succession of valleys and low hills, the latter with reddish and yellowish soils. A few of the hills slopes are terraced, but a considerable number of the terraces originally cultivated have been abandoned. Near Chanlung commence the high hills between the two valleys. Extending to the North from the pass are some out-wash fan soils. The road here enters a narrow canyon between steep stony hills, Figs. 537, 538 (187-1, 2). The latter photograph shows rice fields in the bottom of this canyon.

The new road through the pass, Fig. 539 (187-3), exposes rocks which are light yellowish brown, moderately deeply weathered, yet with soil which is quite shallow due to the steepness of the slopes. South-east of Shiung-tung pass, Fig. 539 (187-3), there are mountains and lower hills. Along the foot of the mountain in the distance to the left of those shown in Fig. 539 (187-3), there are accumulations of outwash material resulting in a gravelly



loam, medium to dark brown in color. In the valley there are a succession of low rice fields and reddish hills, the latter covered with grass and some pines. The hills are partly of residual material and partly of diluvial deposits, as indicated by the quartzitic gravels and their position. This diluvial material is red. It does not seem to have developed distinct horizons; at least they are not evident in the roadcuts.

Rice is planted on the lower slopes and valley bottom, with peanuts, sweet potatoes, and sugar cane on some of the higher terraces of the low hills. Figs. 552, 553, 556 (188-7, 8, 11), show in the distance the conditions referred to above, the low hills, however, being almost indistinguishable from the lower soils. As elsewhere many of the highest terraces have been abandoned and are used only for pasture. At the time of the visit the rice was only about four weeks old and was being fertilized with liquid manure scattered over the field with a long handled dipper. In some places lime was being carried to the fields and broadcasted, the feet of the laborers working the fertilizer into the soil.

TAMSHUI AND ENVIRONS

Tamshui town is located in a considerable valley, by the side of a small river, as is apparent in Figs. 557, 552-556 (188-12; 188-7, 8, 9, 10, 11), show other portions of the same valley from the same vantage point. The hill is shown in Fig. 550 (188-5). The lower portions of this plain are planted to rice. On the slightly elevated places, on slopes or where the soil is lighter, as near the river, the usual upland crops are grown. The soils of the river valley just to the north of the town are a light greyish brown, fine sandy loam to silt loam. Doubtless under the rice there is as well a good deal of clay loam. On some of the lower hill slopes, where the soil is a grey gravelly loam, Fig. 551 (188-6), pears or other fruits are grown. South of Tamshui town is a slightly undulating plain of relatively very shallow soils, grey in color, and over-lying red-beds, Figs. 541, 542 (187-5,6). In places this relatively soft red-bed material forms low hills in the rice plain, Fig. 540 (187-4). Further south, where the elevation is a little higher, the red-bed material is very generally exposed. It is hilly and eroding a good deal. Fig. 543 (187-7) shows these hills with a grey sandy or gravelly loam in the foreground, with some peanuts and rice beyond in the bottom of the small valley.

The hill slopes beyond have eroded, exposing the white and red streaked subsoil material. More favorable conditions for plant growth are found elsewhere as shown in Fig. 544 (187-8). Going south toward Outoukong the road passes through a number of low hills of deeply weathered rocks, Fig. 545 (187-9), which for the most part do not give arable soils. There is some grey sandy loam in very limited bodies. One small knoll of iron cemented material was found near the highway. Because such iron cemented material makes a very good road surface, most of this deposit had already been hauled away for surfacing.

Near the coast are some salt marsh conditions, Fig. 546 (187-10). In this case there are some terraces on the hills. At the port of Outoukong itself there is little agricultural land. Fig. 550 (188-2) shows a few small terraces planted to peanuts on soils derived from red-bed material. In this locality we saw a number of cases where compost material was being prepared. Fig. 547 (187-11) shows a small heap of compost protected from the summer rains.



TAMSHUI - LUNGKONG

This region is one of very low hills extending out into the main valley near Tamshui. As seen from the hill Fig. 556 (188-11), the plain looks practically flat. Slight elevations are apparent further west, as the hills gradually become higher with more pronounced small valleys between, Figs. 558, 560, 562 (189-7, 9, 12). Near the pass, between the Tamshui valley and the Lungkong valley, there is almost no lowland, Fig. 563 (190-1). The material composing the hills seems to be mostly of a red bed nature.

The soils on the hills are a light greyish brown (moist color) sandy loam, the subsoil in places being redder, but usually the subsoil is white splotted with red, Fig. 558 (189-7). There are traces of iron cementing, the material hardening into concretions on the surface of the harder rocks. We saw no development of real concretions or hardpan in any quantity. On some of the hills, where they are never cultivated, there is a 10 to 15 cm layer of stones, mostly angular, and probably quartzitic, quite dark in color, underlain by the red subsoil, which is probably red bed material. The stones are certainly the residue of the decomposition and erosion of higher lying material.

Attention is called to the profile of a rice field soil, Fig. 559 (189-8).

- 0 - 40±cm - brownish grey
- 40 - 50±cm - dark grey
- 50 - 65±cm - streaked with red
- 65±cm to the water level - white with harder red portions.

Note the structure of the subsoil. In the same locality, Fig. 560 (189-9), there is the following profile:

- 0 - 20 cm dark brown loam
- 20 cm and down - a red clay.

The parent upland material in both cases seems to be the same.

The soil of the lowlands is a light greyish brown to medium grey (moist color) sandy loam, fine sandy loam, silt loam, or clay loam. In some places these soils are from recent alluvial material and are several meters deep. In other cases, particularly on the lower slopes, the soils, seeming on the surface to be similar, are about 30 - 40 cm deep and underlain by whitish sandy clay, red splotched, similar to that on some of the hill soils. It is probably all the same material, differing only in topography.

In places in depressions, both on slopes and in little valley bottoms, are exposures of black soil, appearing now as a subsoil, 10 - 20 cm thick, and at times 20 - 30 cm below the present soil surface. These are apparently old swamp soils high in organic matter which, since their formation, have been buried under an overwash of eroded material coming from the hill slopes above. It is likely that at times the black soil has been buried in the course of the making of the terraces. (note separate description of these soils, p. \_\_\_\_).

The upper slopes of the rolling hills are usually not cropped, but carry grass or a few pines, Fig. 563 (190-1). Terraces planted to sweet potatoes peanuts, or sugar cane continue up some of the slopes, some little distance above the irrigation limit for rice. On some of the lower hill slopes, where the soils are deeper and well drained, fruit trees have been grown very successfully. Pears, plums, oranges and lichees are doing well. The mature fruit trees of the Pan brothers annually are each fertilized with about 4 oz of ordinary table salt. No lime is applied to the orchard soils, though it is used generally on rice in this locality.



LUNGKONG VALLEY

This is a fairly large valley of nearly flat land surrounded by higher hills on practically all sides. Here and there in the valley are occasional lower hill or slight undulations. See Figs. 567-570 (190-7, 8, 9, 10), for a practically complete panorama of the valley, from the hill to the South shown in 190-12. As usual, the soils of the lowland rice fields are light greyish brown to brownish grey. In some places the subsoil is for the most part reddish, while in other cases the soil is very shallow and is underlain by a light, nearly white, red splotched subsoil, which is at times a sandy clay. From the hill top looking out over the valley it is very easy to pick out the soil differences. The lower heavy soils are planted to rice while the lighter soils along some of the streams, Fig. 568 (190-8), carry crops of sugar cane or peanuts.

Lime is applied very generally to the rice soils. Limestone is reported to be mined from a depth of from 3 to 7 meters below the surface of the plain. It costs about \$1 a picul and is said to be carried as far as Tamshui for liming rice. Before applying to the rice fields it is at least partially slaked and mixed with ashes. From the bubbling seen in a rice field after

broadcasting the mixture, the lime was obviously not fully slaked before being scattered. At the time of application the smell of the slaking of lime was also noticeable. After broadcasting, the lime is well mixed into the soil with the feet, the worker doing two rows across the field at a time. That the practice of mixing lime and ashes and applying them together to the rice fields seems to be general, would be indicated by Fig. 541 (192-11), at Cheung Muk Tu, where the practice is also employed.

The soils of the hills are very seldom cultivated. One case is shown in Fig. 571 (190-11), where some upland crops are growing on the lower slopes. These soils seem to vary from a gravelly loam to a gravelly sandy loam. Some of the hill slope soils have small iron concretions and in one case in a road cut, Fig. 578 (191-6), was seen quite a goodsized chunk of cemented iron concretionary material, though no true laterite was seen anywhere.

A quite general method of using soil in building construction, shown possibly better here than elsewhere, is that of mixing three parts of gravelly clay loam subsoil material with three parts of sand and one part of lime. The mixture is then allowed to cure in heaps for some time, before it is tamped into walls for very substantial structures. Figs. 390, 565 (166-9; 190-5),

show a similar type of construction fruther south-west. In buildings of this type lintels, second story floors, and small columns are made of reinforced concrete. It seems to be essential to obtain the deeply weathered subsoil material composed of clay and coarse quartz sand or gravel.

### LUNGKONG-PINGWU

West of Lungkong valley proper, the road passes through considerable areas of uncultivated hills and lower slopes, Figs. 575, 576, 579, 580 (191-8, 9, 3, 4). For the most part these slopes are also without trees. The soils vary from a brown sandy loam to a gravelly loam or clay loam, and seem as a whole to be fairly deep. In some cases the hill soils are gravelly or stony with a reddish clay loam below. Quite a large proportion of the lower slopes are a light brown sandy loam and in places, as shown in Fig. 573, 574, 577 (191-1, 2, 5), are planted to sugar cane, peanuts, sweet potatoes or taro. There seems to be no good reason why most of these soils could not well be planted to fruit or to pineapples. The upper slopes as in Figs. 573, 574 (191-1, 2), <sup>and</sup> in places in Fig. 579 (191-8), could well produce trees for fuel or timber, particularly as the region as a whole is especially poor in forest.



Further west, near Pingwu, the hills practically to the tops are now terraced and planted to upland crops. Sugar cane seems to do well on these terraces. One rotation reported for these terraced soils is:

cane
peanuts
sweet potatoes
taro
cane

### HONG KONG

The soils of Hong Kong belong to a number of different groups. The differences depend, among other things, upon the nature of the parent materials, and the age or degree of weathering. As Heanley shows on the map accompanying his paper, there are a very considerable number of different geological formations in the colony, and doubtless these different rocks are responsible for differences in the resulting soils. In addition to the residual soils there are the small bodies of relatively recent alluvial soils in some of the small valleys to the north in new territory.

Most of the rock close about Hong Kong and Kowloon is what Heanley calls the "coastal granite" and it is the soils from this rock that the casual traveller sees eroding on the hillslopes about the harbor, and it is mostly in these rocks that the very deep excavations are being made for highway and other development in the

vicinity of these two cities. And it is to the soils from this "coastal granite" that most of the following notes refer. The notes and photographs have been taken at various times between 1923 and 1932.

The upland soils are light grayish brown or light or medium brown, loams or gravelly loams, from 15 to 30 cm deep. The subsoil is a reddish brown to brownish red or even a bright red in places, with considerable red and white typical tropical mottling. The deeper material, below from 1 to 5 meters, is lighter in color, yellowish to whitish. The profile appears very deeply and thoroly leached, as substantiated by the chemical analyses mentioned below.

The deeply weathered material in its general nature resembles that at Kuala Lumpur, Federated Malay States. The silica crystals 1 to 6 mm in diameter, remain intact; the feldspars, and other minerals have broken down to a smooth, non-plastic material, kaolin. The color of the quartz remains clear; the main mass is reddish with white spots and yellow scattered areas and occasionally redder and yellower veins. However, in Hong Kong there was seen no tendency toward the development of a true lateritic sponge structure, either hard or soft, which does differentiate the results of weathering from those at Kuala Lumpur.

The granite rock, as shown in highway cuts, Figs. 595-599 (2--3, 4, 5, 8, 9), is often weathered from 10 to 20 meters deep. Here and there are remaining the rounded boulders the result of spherical weathering. The fresh granite is a light bluish gray in general color.

These soils residual from granites are undoubtedly the same as those mapped the Lokang series in the Panyu district, Canton.

The lowland alluvial soils are grayish or brownish gray, as characteristic of subaqueous cultivation of rice, which is the main crop. Some taro, peanuts, and sweet potatoes are also grown on these lowlands.

On the hills pines, Melaleuca, Aleurites (tung oil trees), Camphor, Acacia confusa, Albizia lebek, Samanea saman all do well if given a chance, but the pressure of population is very severe, so that afforestation has not made much progress.

Surface and subsoil samples from eight different locations in Hong Kong were analysed mechanically and chemically by the Imperial Institute, the results being published in a Hong Kong White Paper. Unfortunately there is inadequate information given, for example, regarding the nature of the profiles, the sample site topography,



depths of the samples, probability of the profiles being  
undisturbed<sup>etc.</sup>, so that the results reported are not nearly  
of as much interest or value as they would have been  
with the fuller data. It is evident, however, that a  
wide range of general soil conditions is represented, for  
there are samples from "truck gardens," "rice fields," and  
"uncultivated hills." Some of the samples of garden soil  
very evidently have been heavily fertilized and very  
much altered, so that they do not portray the natural  
conditions of the soils as a whole. Taken by and large,  
the results of the analyses indicate just what we would  
expect from observing the soils in the field: that (1)  
the soils are moderately to very acid, with the acidity  
higher in the surface soil than in the subsoil; (2) lime  
is present in extremely small quantities and should be  
added for the best growth of most crops; (3) the  
quantities of plant nutrients are low and "the uncultivated  
soils would probably need extensive manuring to  
be of much use for crops." Herkotsz in commenting on the  
results of the analyses refers to "the miserable state of  
our native soils."

That the soils are low in calcium was demonstrated  
by Twemlow in 1923 on the Government Forestry Plot, in  
the Northern part of New Territory. After liming the soils  
of a field he obtained an unusually marked increase in growth  
of peanuts, with a rich green color of the foliage.

CLIMATE OF KWANGTUNG

The climate of a region is very important, for its bearing upon the nature of the soils which will be formed and also in determining the kinds of crops that can be best produced on these soils. It is thus extremely desirable to have as much information as possible about the various meteorological factors that compose the climate. The meteorological data for most parts of China are extremely scanty. Gauthier and Gherzi of the Zikawei observatory at Shanghai had compiled all the available material on the temperature and the rainfall of China. For the portion of Kwangtung Province under consideration the data which they report have been obtained largely thru the stations of the Chinese Maritime Customs, the the Lighthouse stations, and the colonies of Hong Kong, Macao, and Kwangchouwan. These are all along the coast. The interior stations they report are Canton and Samshui, the former of which was established only a few years ago. Fenzel gives some more recent data for Kwangtung. From the publications of Gauthier, Gherzi, and Fenzel are presented rainfall and temperature data in the tables following. Because of the scarcity of interior stations for which data are available, Wuchou, Kwangsi has been included in the table, as this place is just to the west

of the Kwangtung border. Fenzel by establishing the stations made a very creditable attempt to fill the hiatus in the data for the interior.

Based upon the above observations, as well as probably upon additional information, there have been various attempts to classify the climate of the region under consideration, as well as of all China. Chu gives a concise summary of these classifications, for easy comparison with a series of maps of the various classifications. He calls attention to the deficiencies of these classifications, and proposes a new classification of the climates of China, in which he gives the name "South China Type" to the region which includes Kwangtung Province.

All these classifications, however, include more than the whole of Kwangtung province in one type, yet we can readily see from the data presented that there are considerable variations of sub-types. Fenzel, in an elaborate discussion of the climate of the province in relation to the possibilities of afforestation discusses the differences of the climate in the various parts of the province, and some of the possible reasons for these differences. These same differences in climate are shown in the differences in crops and soils, as well as in the



nature of the forest cover, as one travels from the coast northward to Shiuchou and on toward the border. Fenzel also noted the same differences.

Referring to the rainfall, Gherzi and Fenzel presenting the available data in the form of graphs made it apparent that there is from two to three times as much rain in the warmer half of the year as in the cooler half. This condition greatly affects the nature and speed of weathering of the soil, and also of course the character of the plants best fitted for growth there.

It is extremely unfortunate for the study of the climate in relation to the soils, agriculture, and forestry, that there is no information upon the evaporation of water from the land surface, for even the slightest consideration will show that it is not the total amount of rainfall that falls upon the soil, but that portion which penetrates the soil, which is effective for soil formation or development and crop and tree growth. Also, of course the portion which flows away from the surface, and which may cause erosion, is of importance. One of the main reasons, of course, for the lack of data on evaporation is that there are very practical difficulties in the correct measuring of the rate of evaporation. Suitable equipment can now be easily made and it is hoped

that before long we may have data on this very important feature of the climate.

Needless to say, it is also extremely desirable for the understanding of the soils and agricultural problems of the province that a large number of well distributed meteorological stations, at least for rainfall and temperature be established thruout the province, and that the observations be regularly made and recorded, and Zikawei observatory supplied with copies of records.

## Temperature

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Wuchou	ave	14	14	17	22	26	28	29	29	28	24	19	15
	max	28	31	32	33	36	36	38	38	36	34	33	28
	min	1	0	6	9	15	21	22	23	18	10	6	2
Samshui	ave	14	14	17	22	26	28	29	29	28	24	19	15
	max	32	28	31	34	36	37	37	38	36	36	32	31
	min	0.6	1	4	8	14	20	21	22	18	7	6	2
Canton	ave	14	15	17	21	25	27		27	27	24	20	17
	max	24	24	27	30	33	33	36	37	38	34	32	28
	min	2	5	5	10	20	21	23	26	18	15	6	3
Macao	ave	16	15	17	22	26	28	29	29	28	26	21	17
	max	28	28	29	32	34	38	37	38	38	36	33	31
	min	0	4	4	5	13	21	21	14	17	16	8	5
Hongkong	ave	16	14	17	22	25	27	28	28	27	25	21	17
	max	26	26	28	32	33	35	34	36	35	34	30	28
	min	0	3	8	11	17	21	22	22	19	14	8	5
Pakhoi	ave	16	15	18	24	28	28	29	28	28	25	21	17
	max	29	31	31	36	37	36	37	36	37	36	32	28
	min	0	3	5	9	16	19	21	19	17	11	8	4
Lamko	ave	19	20	21	23	28	29	29	28	27	26	23	19
	max	33	32	38	35	39	38	37	34	32	33	31	26
	min	7	12	11	15	18	22	23	23	21	17	14	9
Swatow	ave	15	14	17	21	24	27	29	28	27	24	20	16
	max	28	29	30	34	37	38	38	38	38	36	33	28
	min	0.6	2	5	9	14	17	18	22	17	13	5	4
Lamocks	ave	14	13	15	19	23	26	27	27	27	24	20	16
	max	21	23	24	28	29	31	32	33	33	32	29	24
	min	8	1	8	11	17	21	22	19	18	16	10	4
Cape Good hope	ave	15	15	16	20	24	27	27	28	28	25	21	17
	max	24	25	27	34	29	32	35	36	36	33	31	27
	min	7	9	9	14	18	23	18	20	19	18	13	7
Breaker point	ave	14	14	16	20	24	26	27	27	27	24	20	16
	max	24	26	26	32	32	33	34	37	36	36	37	26
	min	2	2	6	11	16	19	22	20	16	13	9	2
Chelang Pt.	ave	13	13	16	19	23	24	26	26	24	20	18	14
	max	24	25	25	28	31	33	34	36	34	32	30	25
	min	6	8	8	13	19	23	23	24	19	17	11	7

3-33 years period H. Gauthier 1918 La Temperature en Chine

Zi-ka-wei Observatory, Shanghai.



# Rainy Days

Station	Year Record	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Winter D.J.F.	Spring M.A.M.	Summer J.J.A.	Autumn S.O.N.
Breaker Point	1892-1924	3	5	7	6	10	12	9	10	8	4	3	4	81	12	23	31	15
Swatow	1880-1924	4	8	9	10	12	14	12	11	8	4	4	4	99	16	30	37	16
Lamocks	1892-1924	3	5	5	6	8	10	8	8	6	3	3	3	68	10	20	26	12
Hongkong	1884-1924	8	10	13	14	17	22	19	17	15	9	7	6	157	24	44	58	31
Macao	1910-1924	7	10	13	12	16	20	16	17	13	7	8	7	144	24	40	53	27
Canton	1907-1924	6	9	12	15	17	19	15	16	11	6	6	6	137	21	44	50	22
Samshui	1900-1924	6	9	13	15	17	17	14	14	10	5	5	6	130	22	44	44	20
Lamko	1912-1924	3	4	5	6	7	8	10	10	9	6	5	6	80	13	18	28	21
Kiungchou (Hoihow)	1912-1924	4	7	8	9	12	12	13	12	13	9	8	7	115	18	29	38	30
Pakhoi	1885-1924	6	8	12	10	10	13	16	17	13	7	5	6	123	20	31	47	25
Kwangchouwan		6	8	10	11	13	14	14	16	13	6	6	7	123	21	33	44	26
Wuchou	1898-1924	7	10	11	14	16	15	14	14	10	4	5	7	126	23	41	43	19

# Rainfall in m.m.

Breaker Point	1892-1924	28	47	57	110	201	287	211	271	169	99	37	32	1,549	107	368	768	306
Swatow	1880-1924	35	63	80	144	230	267	198	212	139	73	39	38	1,516	136	453	677	251
Lamocks	1892-1924	28	37	56	99	125	178	166	165	139	85	27	23	1,128	88	280	509	251
Hongkong	1884-1924	33	45	68	135	304	403	356	372	274	130	43	27	2,162	105	507	1,130	420
Macao	1910-1924	22	51	65	122	308	339	236	253	173	113	55	26	1,761	100	494	827	340
Canton	1907-1924	50	75	76	149	254	265	271	283	135	63	44	36	1,699	160	478	819	242
Samshui	1900-1924	42	66	112	184	305	268	244	261	143	70	48	46	1,787	153	602	772	261
Hoyuen (Fenzel) 1/	1920-1926	46	119	148	223	328	288	199	247	108	46	35	19	1,806	100	313	839	554
Lamko	1912-1924	16	18	39	56	84	129	201	211	194	126	50	27	1,150	61	178	541	370
Kiungchou (Hoihow)	1912-1924	25	26	72	94	175	210	247	207	258	191	83	59	1,647	110	341	664	532
Hoihow		35	29	73	102	194	210	231	193	255	204	103	50	1,675	114	369	634	562
Pakhoi	1885-1924	32	33	76	107	171	293	503	507	273	81	45	48	2,169	114	354	1,302	399
Kwangchouwan		16	29	43	77	171	215	220	311	186	60	53	29	1,407	73	291	745	298
Wuchou	1898-1924	30	49	87	171	203	196	167	179	99	36	44	38	1,299	118	460	542	179
Yintak 1/	1919-1926	48	120	134	278	315	341	149	248	93	61	30	28	1,845	119	302	934	490
Shiuchou 1/	1919-1926	38	120	124	202	271	268	84	171	74	62	24	34	1,472	120	282	741	329
Lokchang 1/	1920-1926	40	73	109	169	249	219	137	163	94	108	43	42	1,446	193	222	637	394
Namyung 1/	1919-1926	54	126	153	229	246	271	100	204	83	81	34	34	1,615	149	333	746	387

P. E. G. herzi 1928 E'tude sur la pluie en Chine.

Observatoire de Zi-da-wei Shanghai.

1/ Problems of Reforestation in Kwangtung with respect to

the climate. By G. Fenzel. Lingnan Science Journal, Vol. 9. p. 102.



### THE SOIL MAP

With the exception of the map of the region between Hong Kong & Canton on the small scale of 1:250,000 compiled by the British General Staff and which covered only a small portion of the whole area studied, during the field work we did not have a map suitable for even a reconnaissance delineation of the main soil groups. This deficiency in maps was a great handicap. The base map accompanying this report is the best that we have been able to obtain for the region as a whole. It is a portion of the map of China, 1:1,000,000 scale, compiled by the Geographical Division of the National Geological Survey. Since in places the topography is incorrectly shown, there were added difficulties in delineating the soils as they are known to exist. This soil map has been drawn from the extensive field notes and the numerous photographs, many of which were taken to assist in the subsequent drafting of the soil map, after the base map had been obtained. Of course, nothing can satisfactorily take the place of actual field delineation on a good base map.

Due to this lack of a suitable base map while working in the field, and consequently the inability to map the soil groups at that time, and also because of the very wide range of soil conditions found in the province, particularly the very irregular distribution of very

small bodies of different kinds of soils, it has been quite impossible to subsequently satisfactorily delineate the soils of even those parts of the province which have been traversed personally.

It is also to be regretted that while preparing this soil map I have not had access to a copy of the soil map of the Panyu District, Canton. That map would have been of much assistance in enabling me to show the soils about Canton more accurately in relation to those of other parts of the Province.

As a whole the subdivision and delineation of the soils have been based on topography, making the broad groups: (1) steeper mountains, (2) lower hills and older valley soils, and (3) recent alluvial soils. That these groupings do definitely indicate soil profile differences is clear from the differences pointed out in the soil descriptions. The steeper and higher mountains, due to the topography, have for the most part young or at most immature soils. The lower hills and foot slopes include the older valley soils, and also the lower hill soils belonging to the Canton, and Lokang series, where the weathering has proceeded much farther, giving mature soils. The alluvial soils with a very immature profile are of recently deposited material, mainly from the larger streams. But because of the high water table, and lowland



rice culture, this group could not be expected to develop a normal profile typical of a well drained soil.

The two important upland soils in the Luichou region, the Pakhoi series from unconsolidated sedimentary deposits and the Chumen series from basalt, have been indicated separately, because of their extent, and distinct characteristics, as well as because we spent relatively more time in that region. This separation shows that contrary to previous reports, the most of the Luichou peninsula is not of volcanic material.

Another new series, the Lankong occurs in small patches and only one was found large enough to show on a base map of the scale used. The very old soils south of Kochou have been grouped under the Kochou series and their approximate location has been indicated.

This soil map, therefore, can be considered as only very general and merely suggestive of the general soil groups.

Altho a very large proportion of the province has not yet been studied from the soils standpoint, there is shown on this map certainly by far the greater portion of the recent alluvial soils of the province. The relatively very limited area of these much more fertile soils is an outstanding and unfortunate feature of the soils of the province.

SOIL REGION OF KWANGTUNG

Altho Shaw in 1930 was unable to study soil conditions in South China, on the basis of his studies in the Yangtze valley and in Chekiang he considered that all of the country to the south would fall within his provisional group of "Red Soils", Region 1. And for any very broad grouping this is probably as reasonable a designation as any.

That red, deeply leached soils will be the mature form on the well drained uplands or low hills is well shown by the Canton and Lokang series near Canton, and the Pakhoi and Chumen series in the southwestern part of the province.

However, despite the relatively high temperature and high rainfall of the Kwangtung region studied, there is only a very small proportion of the soils of the region which have reached a sufficient degree of sub-aerial maturity to have a definite red color. There are several reasons: One is that the topography is about 90% hilly and mountainous, with thus a generally prevailing condition where erosion of soil material, even under normal conditions of vegetative cover, is such that maturity and the consequent red color is seldom attained. A second reason is that the prevailing type of agriculture is a "rice agriculture," with the predominance for long

periods annually of subaqueous soil conditions, and the consequent prevention of a development of red soils, rather, there prevail the conditions which cause the reversion of a red soil to a light bluish gray mottled color.

It would therefore seem much better, to avoid the use of the term "red" and following a suggestion of Mohr. rather to call the soil region in which Kwangtung lies, the "Sub-Tropical lixivium Soil Region", a name indicating that the mature soils are thoroly leached, be they black as in the depressions of the uplands, or red as on the well-drained uplands, or bluish or whitish as on the lower alluvial plains, where the "rice soils" predominate.

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For the summary of this report please  
refer to the first two pages.

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Dr. Robert L. Pendleton's Photographic Collection  
of China

<u>Rolls</u>	<u>Month</u>	<u>Year</u>
1-2	May	1931
4-7	June-July	1931
8-18	Aug.-Sept.	1931
19-35	Sept.	1931
36-58	Oct.	1931
60-64	Nov.-Dec.	1931
65-82	Jan.	1932
83-98	Jan.-March (possibly April too)	1932
108-114	June	1932
115-155	July	1932
156-191	Aug.	1932
192-193	Late Aug.-Early Sept.	1932
194-200	Late Sept.	1932
201-211	October	1932
212-213	March	1933
214-223	May	1933





Fig. 1. Rice and beans in distance on Lungyentung series of soils. Canton series on the hills at the right. North east of Canton along the road to the University Farm. June 1932. (RLP Photo No. 109-7)



Fig. 2. Shaley red beds, with some conglomerate; white weathered spots and veins. Northeast of Canton along the road to the University Farm. June 1932. (RLP Photo No. 109-8)



Fig. 3. Building mushroom beds of rice straw. Rice growing on Lungyentung series in the valley bottom. Graves in Canton sandy loam on the hill beyond. Northeast of Canton. June 1932. (RLP Photo No. 109-9)



Fig. 4. Hill slope of Lokang sandy loam planted to trees, eroding badly; bare granite boulders on distant hill. Agricultural College Farm, Sun Yat Sen University northeast of Canton. June 1932. (RLP Photo No. 109-11)



Fig. 5. Deep ravine eroded in Lokang sandy loam. Clean culture for afforestation is seriously increasing the erosion. Agricultural College Farm, Sun Yat Sen University northeast of Canton. June 1932. (RLP Photo No. 109-12)



Fig. 6. Clean culture agave plantation seriously eroding; distant hills also eroding badly. The soil is so poor that the plants show almost no growth. Agricultural College Farm, Sun Yat Sen University northeast of Canton. June 1932. (RLP Photo No. 110-1)



Fig. 7. Vegetable beds in valley bottom, Eucalyptus nursery at right; bad erosion beyond in distance. Agricultural College Farm, Sun Yat Sen University northeast of Canton. June 1932. (RLP Photo No. 110-2)



Fig. 8. Ravine, about 8 m. deep in forest plantation. This erosion is growing yearly and is very serious. Soil is practically all a uniform brownish red to purplish red. Eucalyptus in distance. Agricultural College Farm, Sun Yat Sen University northeast of Canton. June 1932. (RLP Photo No. 110-3)



Fig. 9. Detail of photo 110-3 showing bare surface soil and eroded face of ravine. Agricultural College Farm, Sun Yat Sen University northeast of Canton. June 1932. (RLP Photo No. 110-4)





Fig. 10. Characteristic roughly hexagonal cracking of the bare surface soil on a road. Road eroding seriously because of slope. Agricultural College Farm, Sun Yat Sen University northeast of Canton. June 1932. (RLP Photo No.110-5)



Fig. 11. Crotalaria juncea a very promising green manure plant, on rice valley bottom soil. It would have been more worth while to have planted this on poor upland soil to see what it would do. Agricultural College Farm, Sun Yat Sen University northeast of Canton. June 1932. (RLP Photo No.110-6)



Fig. 12. Soil Profile of the Lokang series in an excavation. Note gravel layer at about one meter depth. Pines in distance. Agricultural College Farm, Sun Yat Sen University northeast of Canton. June 1932. (RLP Photo No. 110-7)



Fig. 13. Deep side hill road cut in Lokang series of soils. This is a deeply weathered granite. The surface soil is reddish-brown, the deeper layers mottled red and white. Northeast of Canton. June 1932. (RLP Photo No. 110-9)



Fig. 14. Grave-covered hills of the Lokang series of soils. From same point as 110-9. Northeast of Canton. June 1932. (RLP Photo No. 110-10)



Fig. 15. Detail of deeper material of cut shown in 110-9. The weathering has completely broken down the rock structure, leaving clay and quartz grains. North east of Canton. June 1932. (RLP Photo No. 110-11)



Fig. 16. Cucurbits near, rice beyond on Lung-yentung soils, 5 km NE of Canton. Granitic hills in distance. June 1932. (RLP Photo No. 110-12)



Fig. 17. Chuk'iang series (loam?) Beans and taro at left; rice at right. East of Canton. June 1932. (RLP Photo No. 111-4)



Fig. 18. Chuk'iang series (loam?) Rice, orchard of guavas and citrus at right; village grove in distance. About 4 km east of Canton. June 1932. (RLP Photo No. 111-5)





Fig. 19. Garbage heaps on creek bank. This material is brought by boat from Canton city and is used as a fertilizer. Pole beans are beyond. View from Shihpai series out over Chuk'iang series. About 4 km east of Canton. June 1932. (RLP Photo No. 111-6)



Fig. 20. Canton series (loam?) East of Shekpai. Profile showing a strongly weathered conglomerate. The subsoil is mottled white in a red ground. About 5 km east of Canton. June 1932. (RLP Photo No. 111-7)



Fig. 21. Canton series, gravelly in the foreground. Young and very small Eucalyptus trees near, natural cover very sparse. About 10 km east of Canton. June 1932. (RLP Photo No. 111-8)



Fig. 22. Chuk'iang series. Rice at left, lichi and other fruits beyond. About 5 km north of Whampoa, and about 15 km east of Canton. June 1932. (RLP Photo No. 111-9)



Fig. 23. Looking toward Shihpai valley over grave land on Canton series sandy loam. Lokang series (?) on distant hills. About 5 km north of Canton. June 1932. (RLP Photo No. 111-11)



Fig. 24. Canton sandy loam, subsoil strongly variagated. Graves, taro, and beans; rice beyond. From same site as 111-11, this looking south. About 5km north of Canton. June 1932. (RLP Photo No. 111-12)



Fig. 25. Shihpai "fine sandy loam" here really a clay loam. Cucumbers climbing on sloping frames. Village in trees in distance. About 7 km north of Canton. June 1932. (RLP Photo No. 112-1)



Fig. 27. Recent road cut, 3m high, surface soil shaley, 10-15 cm. deeper material thoroly Kaolinized. About 15 km north of Canton. June 1932. (RLP Photo No. 112-3)



Fig. 28. Narrow shallow valley: fruit and beans. Grass near and on distant hill. From same point as 112-3. About 15 km north of Canton. June 1932. (RLP Photo No. 112-4)





Fig. 29. Soil profile exposed in a road borrow pit: 30cm<sup>+</sup> grayish brown clay loam; below a light bluish-white, red-spattered sandy clay. (Shihpai series?) Rice seed beds and garden beyond. About 8km north of Canton. June 1932. (RLP Photo No. 112-5)



Fig. 30. Shihpai series: 10-20cm grayish brown soil; below, a light bluish-white sandy clay with red spots. Rice poor. Road borrow pit filled with water. Canton. June 1932. (RLP Photo No. 112-6)



Fig. 31. Upper farm valley. Rice at right, bananas and beans at left, soils gray sandy loam. On hills are grassy slopes with some pines and little erosion. Lingnan University Farm. Ooi T'ung. Chungshanhsien. June 1932. (RLP Photo No. 112-12)



Fig. 32. Rice fields in the same valley as shown in 112-12. Pandan hedges at left. Erosion starting on the hills. Lingnan University Farm. Ooi T'ung. Chungshanhsien. June 1932. (RLP Photo No. 113-1)



Fig. 33. Hillside grave. Soil a light yellowish brown sandy loam, very poor. Cajanus and maize beyond. Cajanus indicus is one of the very promising upland crops for green manure, nurse crop for trees, or for fuel. Pines on hills. Lingnan University Farm. Ooi T'ung. Chungshanhsien. June 1932. (RLP Photo No. 113-2)



Fig. 34. Palm plantation on sloping land in middle distance; some rice in valley bottom. Pines on seriously eroding hill in distance. These upland plantings all show the serious lack of nitrogen and other plant food elements. Lingnan University Farm. Ooi T'ung. Chungshanhsien. June 1932. (RLP Photo No. 113-3)



Fig. 35. Palm plantation near. Rice in valley bottom. Eroded hill with pines in distance. Lingnan University Farm. Ooi T'ung. Chungshanhsien. June 1932. (RLP Photo No. 113-4)



Fig. 36. From cultivated hill top planted to bamboo, looking out over a rich village in the plain. Badly eroding furrow in foreground. Lingnan University Farm. Ooi T'ung. Chungshanhsien. June 1932. (RLP Photo No. 113-5)



Fig. 37. The same bamboo hill, looking in opposite direction. A badly eroding furrow near. Pines on the hill beyond. Lingnan University Farm. Chungshanhsien. June 1932. (RLP Photo No. 113-6)





Fig. 38. Bamboo plantation, cultivated hill top. An eroding cross furrow; extends from the foreground to the distant road; eroded pines on the hill in the distance. There is a very serious question as to whether these upland hills and slopes should ever have been plowed. The erosion is already serious, and it will almost certainly get much worse with time. If plowing was to have been done, it should have been strictly on the contour; or preferably in contour zones. Lingnan University Farm. Ooi T'ung. Chungshanhsien. June 1932. (RLP Photo No. 113-7)



Fig. 39. Early and late rice on very low land. Transplanting dates 2 weeks apart, in March, the early maturing sort is harvested in June, the later in November. This obviates planting a second crop during the usual period of very high water in mid-summer. Agricultural College Farm, Sun Yat Sen University, Tsuihang, Chungshanhsien. June 1932. (RLP Photo No. 113-8)



Fig. 40. Dikes near river, sedges are grown for three years to fix mud, raising the soil level almost  $1/3m$  outside of dike. The land is then diked and rice planted. Agricultural College Farm, Sun Yat Sen University, Tsuihang, Chungshanhsien. June 1932. (RLP Photo No. 113-9)



Fig. 41. Women weeding rice. Agricultural College Farm, Sun Yat Sen University, Tsuihang, Chungshanhsien June 1932. (RLP Photo No. 113-10)



Fig. 42. University Farm Roads, poor pineapples. Non-contour furrows are visible. These are very bad in intensifying erosion. At the foot of the mountains at the right in the extreme distance is the location of the Lingnan University Farm at Ooi T'ung. Agricultural College Farm, Sun Yat Sen University, Tsuihang, Chungshanhsien. June 1932. (RLP Photo No. 114-1)



Fig. 43. Another dam, from below. A low cement "core" has been located above rather than in the center of the dam when it would be better. The outlet pipe is visible at the right. Agricultural College Farm, Sun Yat Sen University, Tsuihang, Chungshanhsien. June 1932. (RLP Photo No. 114-2)



Fig. 44. Building dam across a ravine. Looking south toward the proposed harbor at Chungshan. Agricultural College Farm, Sun Yat Sen University, Tsuihang, Chungshanhsien. June 1932. (RLP Photo No.114-3)



Fig. 45. The well maintained company Auto Road from Macao to Shekwei, at a junction. Uniformed traffic cop. A forest experiment station beyond at the right. Chungshanhsien. June 1932. (RLP Photo No. 114-5)



Fig. 47. Rice plains and steep mountains north of Macao. Chungshanhsien. June 1932. (RLP Photo No.114-9)





Fig. 48. Lighthouse hill from the northeastern part of Macao. In this locality were found a number of naturalized, vigorously growing trees of Leucaena glauca, the very promising fuel & nurse crop for afforesting the hills of this region. June 1932.  
(RLP Photo No. 114-11)



Fig. 49. Young orange trees on heaps of soil otherwise poorly drained, in a rice growing locality. Shihpai series: † 0-50cm yellowish gray clay loam; † 50-75cm variable, † 75-100cm whitish yellow clay. About 10km north of Canton. July 1932. (RLP Photo No. 116-1)



Fig. 50. Peach orchard on Shihpai series. Mr. Pan. About 15 km north of Canton. July 1932.  
(RLP Photo No. 116-2)



Fig. 51. Hills near and distant have soil of the Canton series: lower valley soils are Shaoping series growing rice, peaches, and beans. About 15km north of Canton. July 1932. (RLP Photo No. 116-3)



Fig. 52. Fuling series on a hill. The soil has been badly disturbed to get dark material to adulterate coal. Shaoping series is on plain in distance. Messers Pan and Lü. About 15km north of Canton. July 1932. (RLP Photo No. 116-4)



Fig. 53. Fuling market town beyond the hill. Canton series near and on the second hill. Shaoping plains soils at left are planted to rice. About 15km north of Canton. July 1932. (RLP Photo No. 116-5)



Fig. 54. Peaches and taro on Shaoping series, rice fields surround this plot, hence the high water table. About 12km north of Canton. July 1932.  
(RLP Photo No. 116-6)



Fig. 55. Rice on Shaoping series of soil. Bamboo and village trees in distance. About 20km north of Canton. July 1932. (RLP Photo No. 116-7)



Fig. 56. Lantana sandy loam. Light yellowish gray 0-20cm; light yellow clay loam below; the deeper subsoil is reddish and whitish mottled. Cucurbits near, peanuts in middle distance, taro beyond. Swamp far beyond. About 25km north of Canton. July 1932.  
(RLP Photo No. 116-8)





Fig. 57. Lantan series of soils, lower and higher phases. Rice planting in the foreground, grass and graves beyond. This soil is mapped all one series, tho the characteristics as indicated by the use, as well as the profile, are quite different. About 25km north of Canton. July 1932. (RLP Photo No. 116-9)



Fig. 58. Lantan series. Lowland rice. In distance are well sweeps for raising irrigation water. About 25km north of Canton. July 1932. (RLP Photo No. 116-10)



Fig. 59. Profile of Shihpai series exposed in a roadside wash. Yellowish brown sandy loam to loam, to 40 or 60 cm; below a dark bluish clay, in large blocks. About 5km north of Canton. July 1932. (RLP Photo No. 116-11)



Fig. 60. Road cut showing profile of Lokang series of residual soils. Forest Station of the Sun Yat Sen University, about 10km northeast of Canton. July 1932. (RLP Photo No. 117-1)



Fig. 61. Road cut near last, showing variations in depth in the Lokang series. Note the results of afforestation with pine. Forest Station of the Sun Yat Sen University, about 10km northeast of Canton. July 1932. (RLP Photo No. 117-2)



Fig. 62. Plains to the South. Lokang series soils in the foreground, Lungyentung and Canton series in the far distance. From the Forest Station, Sun Yat Sen University, about 10km north east of Canton. July 1932. (RLP Photo No. 117-3)



Fig. 63. Plains to the southeast, toward Whampoa. Lokang series of soils near, Lungyentung and Canton series on the plains. From the Forest Station, Sun Yat Sen University, about 10km northeast of Canton. July 1932. (RLP Photo No. 117-4)



Fig. 64. Lowland to the east south east. Lokang series of soils near. Lungyentung and Canton series in the distance. From the Forest Station, Sun Yat Sen University, about 10km northeast of Canton. July 1932. (RLP Photo No. 117-5)



Fig. 65. Lungyentung clay loam profile, exposed in a roadside borrow pit. About 10cm. of gray clay loam; 15cm. of gray clay; sandy clay below 25cm. Lokang series on the hills at the extreme left in distance. Along the Saho Road, east of Forest Station, and about 15km northeast of Canton. July 1932. (RLP Photo No. 117-6)





Fig. 66. Lungyentung series of soils with peanuts near, and rice beyond; Lokang series on the hills; very young pine planted on the hills. About 15km northeast of Canton. July 1932. (RLP Photo No.117-7)



Fig. 67. Rice on Lungyentun soils, Canarium, "olives", on terraces on Lokang soils beyond. Vegetables in the middle distance at the left. About 15km northeast of Canton. July 1932. (RLP Photo No.117-8)



Fig. 68. A stream cut into a hill of Lokang soils showing the deeply weathered rock and soil material. Pines planted above. Near is ginger on ridges, young egg plants at one side. Between the rows are chicken feathers and chicken manure, covered with soil; a legume mulch is about the ginger. About 15km north east of Canton. July 1932. (RLP Photo No. 117-10)



Fig. 69. Harvesting rice. Water cypress in distance. These trees are an interesting adaptation to peculiar soil conditions. Along the Samshui Railway about 10km west of Canton. July 1932. (RLP Photo No.118-9)



Fig. 70. Hills of red soil (Canton or Lokang series) with old terraces. Flood waters cover the alluvial soils usually planted to rice. Along the Canton-Samshui Railway. July 1932. (RLP Photo No.118-10)



Fig. 71. Railway pit in deeply weathered purplish red material. Along the Samshui Railway, about 20km west of Canton. July 1932. (RLP Photo No. 118-11)



Fig. 72. Rice fields. Bare eroded hills in the distance. Along the Samshui Railway, about 25km west of Canton. July 1932. (RLP Photo No. 119-1)



Fig. 73. Another place where West River has cut into the bank exposing a profile of the Canton (?) series. Grayish brown soil  $\pm \frac{1}{2}$  meter; red gravel  $\pm 1\frac{1}{2}$ m; purplish red substratum  $\pm 3-4$ m; gravelly at the water line. About 10km west of Samshui. July 1932. (RLP Photo No. 119-8)



Fig. 75. The river dike along the north bank of the West River. Some distant low fields visible beyond the dike. For scale note the 3 children and water buffalo at right on dike. About 15km west of Samshui. July 1932. (RLP Photo No. 119-10)





Fig. 76. Looking south across the West River, from near the north bank, from near the north bank, from point where 119-10 has been taken. Chien Fong village on the narrow alluvial plain is barely visible. A few of the lower slopes of the hills are terraced. The hills as a whole are covered with grass only. These hills would produce a great abundance of fuel for the delta region of Kwangtung if they were planted with *Leucaena glauca*. (See 117-12). About 15km west of Samshui. July 1932. (RLP Photo No. 119-11)



Fig. 77. A steep cassava field. Most of the slope is covered with grass. Along the north bank of the West River, about 10km east of Nam Kong Hao and about 130km west of Canton. July 1932. (RLP Photo No. 120-1)



Fig. 78. Mulberry plantation on a small alluvial terrace. Old, uncultivated terraces are up on the slopes. On some of the steep slopes, untterraced, are cultivated cassava and taro. The pines are better than usual. Along the north bank of the West River about 10km east of Nam Kong Hao and about 130km west of Canton. July 1932. (RLP Photo No. 120-2)



Fig. 79. Mulberry and fruit trees on an alluvial terrace. Upland rice and cassava planted on some of the hills. Pines planted on an eroded hill at the right. Along the north bank of the West River about 10km east of Nam Kong Hao and about 130km west of Canton. July 1932. (RLP Photo No. 120-3)



Fig. 80. Mouth of the Loting Kong at Namkonghou. July 1932. (RLP Photo No. 120-4)



Fig. 81. Mouth of the Loting River at Nam Kong Hao. Pine planted on the hill at the left. Looking south from the West River. About 140km west of Canton. July 1932. (RLP Photo No. 120-6)



Fig. 82. Hills covered mostly with ferns used for fuel. A few pines at the left and a little cultivation in the valley at the right. Bamboo about the village at the foot of the hill. Timber rafts along the west bank of the Loting River. July 1932. (RLP Photo No.120-7)



Fig. 83. Steep fuel trails running almost directly down the slope, from A to B, and from C. to D. Bundles of pine boughs are rolled or dragged down these trails. A heap of pine bough bundles at B. Taken during a rain. East bank of the Loting River. July 1932.(RLP Photo No.120-8)



Fig. 84. Bamboo grove about a small village on west bank of the Loting River. Above are some terraces with cassava, some pine higher. There is a steep fuel trail down the hill at the left. The soil is apparently different, as it doesn't erode much. Loting River about 2.5km south from the West River. July 1932.

(RLP Photo No. 120-9)





Fig. 85. East bank of river at same place as 120-9. A low flood plain at eye level, pines are on the slope. An alluvial fan extends out into the plain below the village. The hill soils are perhaps of the Lokang series. Loting River. July 1932.  
(RLP Photo No. 120-10)



Fig. 86. Steep slopes and straight fuel paths above the east bank of the river. Grass and ferns on the slope. For scale see the fishing raft and derrick net along the shore. Note succession of paths at A-B where after a path becomes too deeply worn, a new path is started. Loting River. July 1932. (RLP Photo No. 120-11)



Fig. 87. Westward up a side valley from the Loting River. Bamboo; below fuel trails on the slopes, upland rice beyond in center distance. July 1932.  
(RLP Photo No. 120-12)



Fig. 88. Tung Chow village. Tower and pines on the hill top at the right. Rice on the lower terraces. East bank of the Loting River. July 1932.  
(RLP Photo No. 121-1)



Fig. 89. Lowland rice on lower terraces at left. A good stand of young pine on the hills. Seong Cheng village. West bank of the Loting River. July 1932.  
(RLP Photo No. 121-2)



Fig. 90. Rafting bamboo. A brick kiln and piles of fuel at left on the low narrow flood plain. West bank of the Loting River. July 1932.  
(RLP Photo No. 121-3)



Fig. 91. Irrigated rice on lower terraces, and clumps of bamboo. A badly eroded trail barely visible at the left. In the distance are a steep trail and cut fuel patches. Some scattered small pines. The rock seems to be thin bedded. The soil is brown to grayish brown; the subsoil a light brown. An older terrace is of redder soil and is eroding badly. East bank of the Loting River. July 1932. (RLP Photo No. 121-4)



Fig. 94. A small plain planted to irrigated rice on the eastern bank of the Loting River. Graves in red soil on the hills. The stern of our river boat is in the foreground, near. We transferred here to a motor bus. Another river boat being rowed down stream. Shü Yü Hao. July 1932. (RLP Photo No. 121-7)



Fig. 95. A large lowland rice growing plain south west of the Loting River. Our boats are visible below. Shü Yü Hao. July 1932. (RLP Photo No. 121-8)





Fig. 96. Terminus of the motor road at Tai Wan on which we travelled south west from Shü Yü Hao. Eroded hills with some pines. West bank of Loting River, 20km northeast of Loting. July 1932. (RLP Photo No. 121-9)



Fig. 97. Eroding hills with scattering pines and some terraces. The lower terraces in valleys are planted to rice, the upper terraces to peanuts and cassava. The underlying rock is red (red beds?). The soil is red but not weathered to the degree that the Canton series is. These are the hills thru which runs the motor road shown in 121-9. Tai Wan, near the Loting River, 20km northeast of Loting. July 1932. (RLP Photo No. 121-12)



Fig. 98. Looking down river and along an irrigation ditch. Lowland rice at the right. Lime kilns at left along the river. Distant hills almost uneroded. Taiping, 15km south of Loting, at the end of the motor road. July 1932. (RLP Photo No. 122-1)



Fig. 99. Looking up the river from same place as No. 122-1. Wood carriers crossing bridge. Lime kilns at left. Rice on the plain in the distance. Lower slopes of the distant hill are terraced. These are the same hills shown in 122-5,6,7. Taiping 15km south of Loting. July 1932. (RLP Photo No. 122-2)



Fig. 100. Quick lime to be slaked and as a powder applied to the rice fields. The local rate is from 1/3 to 3 piculs @ mow for every crop, i.e. 2 times a year. The cost of the lime is \$3 @ picul. Taiping about 15km south of Loting. July 1932. (RLP Photo No. 122-3)



Fig. 101. Profile exposed in a roadside borrow pit; dark soil  $\pm$  10cm; subsoil yellowish. Peanuts in the foreground, a little sorghum at the right. Rice beyond in the distant fields. The same hill as shown in 122-2. There are terraces on the lower slopes of this hill. South of Taiping and about 16km south of Loting. July 1932. (RLP Photo No. 122-5)



Fig. 102. A detail of the conical hill shown behind the tree at the right in view 122-2; also closer to the hills and slightly to the right of view in 121-5. Rice extends from the foreground to the foot of the hill. There are eroded terraces on the lower slopes and an old irrigation ditch around hill. South west of Taiping and about 16km south of Loting. July 1932.

(RLP Photo No. 122-6)



Fig. 103. Recently plowed and ready to harvest rice fields; in the distance a village at the left. Southwest of Taiping and about 18km south of Loting. July 1932.

(RLP Photo No. 122-8)



Fig. 104. Rice in a very narrow valley, cassava at right on steeper terraced slope; on the upper hills at left are patches where ferns have been cut off for fuel. South west of Taiping and about 20km southwest south of Loting. July 1932. (RLP Photo No. 122-9)





Fig. 105. Across valley about 200m wide; not far up valley from 122-9. Crops of rice, sorghum, and peanuts; some bamboo at creek; on steep hills are patches where ferns have been cut off. Some house roofs near. South west of Taiping and about 20km south west south of Loting. July 1932. (RLP Photo No. 122-10)



Fig. 106. Looking down the valley, across the stream. A small village is in the side valley. South west of Taiping and about 20km south west south of Loting. July 1932. (RLP Photo No. 122-11)



Fig. 107. Wood, Hoh K, and Lo on the new Kwangtung south west road. Shallow brown residual soils, rice below the road. South west of Taiping and about 20km south west south of Loting. July 1932. (RLP Photo No. 122-12)



Fig. 108. Up the valley. Rice on the terraces. Juk Station at foot of distant hill at the right. South west of Taiping and about 22km south west south of Loting. July 1932. (RLP Photo No. 123-1)



Fig. 109. Rice in the valley. More brush and trees on the hills. At the left distance are the first of the Cunninghamia forest plantings seen along this route. South west of Taiping and about 25km south west south of Loting. July 1932. (RLP Photo No. 123-2)



Fig. 110. Sliding soils along new road. About  $\frac{1}{2}$  m gray soil; below is a reddish brown gravelly loam. Taro and beans above. Hoh K. South west from Taiping and about 25km south west south of Loting. July 1932. (RLP Photo No. 123-3)



Fig. 111. Young Cunninghamia plantation on lower slopes. Rice in the valley on both sides of the stream, and on terraces about the house between the rice and the trees are cassava and taro. South west of Taiping and about 26km south west south of Loting. July 1932. (RLP Photo No. 123-4)



Fig. 112. Side valley with rice on terraces, Cunninghamia plantations on slopes, graves in the brush and grass higher up. Pines and Cunninghamia in the foreground. South west of Taiping and about 27km south west south of Loting. July 1932. (RLP Photo No. 123-5)



Fig. 113. Rice in the foreground and across the stream. On the opposite bank of the stream is a water wheel, to raise water for irrigating the rice. Young and older Cunninghamia plantations above. South west of Taiping and about 28km south west south of Loting. July 1932. (RLP Photo No. 123-6)





Fig. 114. A farmyard, with fish pond near. Flailing harvested crops near the buildings. There is a good growth of young pine on the hill beyond. South west of Taiping and about 38km south west south of Loting. July 1932. (RLP Photo No. 123-7)



Fig. 115. Grove of undisturbed tree growth about a temple. This shows what these hill and mountain slopes are capable of producing if they have a chance. Rice near and on distant terraces. South west of Taiping and about 28km south west south of Loting. July 1932. (RLP Photo No. 123-8)



Fig. 116. A water wheel raising water for rice irrigation. South west of Taiping and about 29km south west south of Loting. July 1932. (RLP Photo No. 123-9)



Fig. 117. A lower alluvial plain planted to rice, photographed from a higher terrace. The new road at the left. South west of Taiping and about 29km south west south of Loting. July 1932. (RLP Photo No. 123-10)



Fig. 118. A broader valley farther up the same stream. Rice. Smoke from burning fresh rice straw. Temple trees at the left. South west of Taiping and about 30km south west south of Loting. July 1932.  
(RLP Photo No. 123-11)



Fig. 119. Hill south of school at Hap Shui. Rice on irrigated terraces to water limit, and also in the foreground. About 40km south west south of Loting. July 1932. (RLP Photo No. 123-12)



Fig. 120. Bare soil about grave; ferns near and beyond. The soil is a brownish gray clay loam  $\pm$  0-5cm; brown clay loam  $\pm$  5-30cm; brownish red gravelly clay loam below  $\pm$  30cm; apparently from granite. Rice and stream in the valley in the distance. Hap Shui, about 40km south west south from Loting. July 1932.  
(RLP Photo No. 124-1)



Fig. 121. Rice fields in the valley about the Hap Shui Middle School. A small village near, others at the foot of the distant hills. Hap Shui, about 40km south west south from Loting. July 1932.  
(RLP Photo No. 124-2)



Fig. 122. Unirrigated terraces on a hill behind the hill shown in 123-12 and 124-1. Pole and soy beans, some cassava and sesamum. There are many fallow terraces. Hap Shui about 40km south west south from Loting. July 1932.  
(RLP Photo No. 124-3)





Fig. 123. Valley at the left, to the north of, 124-3; irrigated rice below; dry terraces above, grass, ferns and also graves on higher hills. Hap Shui about 40km south west south of Loting. July 1932.

(RLP Photo No. 124-4)



Fig. 124. Looking down the river valley, south of the town which is just visible at the left. A very small water power mill is located at the left of the stream. Rice fields on all available land. Hap Shui about 40km south west south of Loting. July 1932. (RLP Photo No.124-5)



Fig. 125. The compact, old town of Hap Shui. The water power mill at the right. Big Ficus tree above and beyond the town. Note the big old stream terrace beyond the town. Rice in the valley and on the stream terrace. To left of 124-5. Hap Shui. July 1932. (RLP Photo No.124-6)



Fig. 126. Up the valley, across the slope shown in 123-12 and 124-1,2. Rice below and on the terraces. Grass in the foreground. Hap Shui about 40km south west south of Loting. July 1932. (RLP Photo No. 124-7)



Fig. 127. Brick clay pit in rice field. A heap of soil is in the middle, beyond. A sharp line is apparent between the bluish gray soil and the light yellowish brown subsoil. About 1 km south east of Hap Shui and about 40km south west south of Loting. July 1932.  
(RLP Photo No. 125-1)



Fig. 128. Threshing box and partly harvested rice. Hill partly in irrigated rice and partly in grass and trees. About 1 km south east of Hap Shui and about 40km south west south of Loting. July 1932.  
(RLP Photo No. 125-2)



Fig. 129. Up stream from a temple. Large pines at left. A diversion wier for irrigation water in the stream in the distance. Rice beyond on the river terrace. About 2km south east of Hap Shui and about 40km south west south of Loting. July 1932. (RLP Photo No. 125-3)



Fig. 130. Very narrow rice terraces. Our party on the trail. About 3km south east of Hap Shui and about 40km south west south of Loting. July 1932. (RLP Photo No. 125-4)



Fig. 131. Cunninghamia nursery, pines at the left. Poles of felled trees above at right. Rice near in the foreground. About 4km south east of Hap Shui and about 40km south west south of Loting. July 1932. (RLP Photo No. 125-5)





Fig. 132. Broad rice fields. Irrigated rice and new dry terraces above. Cunninghamia and pine on upper slopes. About 4km south east of Hap Shui and about 40km south west south of Loting. July 1932 (RLP Photo No. 125-6)



133.

Fig. 133. Irrigated rice terraces beyond and below. Paved trail near; grove of old trees beyond at left. About 5km south east of Hap Shui and about 40km south west south of Loting. July 1932. (RLP Photo No. 125-7)



Fig. 134. Seed bed for second rice crop, made by pulling up and transplanting almost mature 1st crop rice along edges of adjacent terraces above and below (near 125-7). About 5km south east of Hap Shui and about 40km south west south of Loting. July 1932. (RLP Photo No. 125-8)

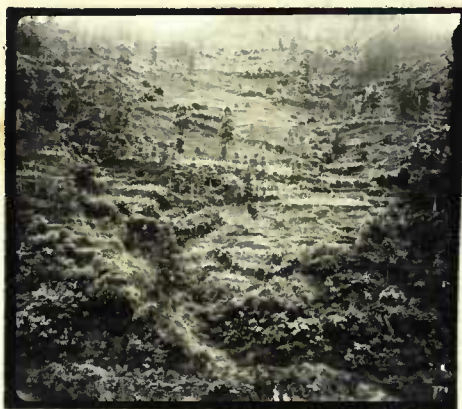


Fig. 135. Dry terraces on a steep slope. Cunning-  
hamia nurseries and some mature trees. About 5km south  
east of Hap Shui and about 40km south west south of  
Loting. July 1932. (RLP Photo No. 125-9)



Fig. 136. Tea bushes in shade of pines. Soil a  
red clay loam. Our party on trail. About 5km south  
east of Hap Shui and about 40km south west south of  
Loting. July 1932. (RLP Photo No. 125-10)



Fig. 137. Rice near and on some lower terraced  
slopes. Same valley as in 125-6. Village where we  
were guests at middle-school-leaving feast. About 4km  
south east of Hap Shui and about 40km south west south  
of Loting. July 1932. (RLP Photo No. 125-12)



Fig. 138. A roadside profile showing gray soil; about  $\pm$  30cm, brown;  $\pm$  2cm, gray;  $\pm$  5cm, brown;  $\pm$  2cm; a light gray below; planted to sweet potato. About 1km south west of Hap Shui and about 41 km south west south of Loting. July 1932. (RLP Photo No. 126-1)



Fig. 139. Boy and water buffalo plowing under much rice straw. About 1 km south west of Hap Shui and about 41 km south west south of Loting. July 1932. (RLP Photo No. 126-2)



Fig. 140. Plowing under rice straw. Harvesting rice in the distance. About 1 km south west of Hap Shui and about 41 km south west south of Loting. July 1932. (RLP Photo No. 126-3)





Fig. 141. A small village. Partly plowed rice fields at the left. The smoke is from the burning fresh rice straw for ash for the rice fields. A well wooded hill beyond. About 2km south west of Hap Shui, and about 41 km south west south of Loting. July 1932. (RLP Photo No. 126-4)



Fig. 142. Rice terraces both sides of the central stream. At right an irrigation ditch below the road. A good stand of pine on the hill at the right. About 3km south west of Hap Shui and about 41 km south west south of Loting. July 1932. (RLP Photo No. 126-5)



Fig. 143. Rice terraces on larger scale old stream terraces. The higher mountains are grassy, (*Imperata*), no shrubs or trees except in some ravines. Tai Shwi Liang. About 4km south west of Hap Shui and about 41 km south west south of Loting. July 1932. (RLP Photo No. 126-6)



Fig. 144. The end of the main valley as it rises steeply to the divide. Trees mostly pine. About 5km west of Hap Shui and about 41 km south west south of Loting. July 1932. (RLP Photo No. 126-7)



Fig. 145. The south east facing slope of a side valley to the north of the one shown in 126-7. Rice terraces scattered among plantings of pine, bamboo and Cunninghamia. About 5km west of Hap Shui and about 41 km south west south of Loting. July 1932. (RLP Photo No. 126-8)



Fig. 146. Farther up the same south east facing steep slope of same valley as shown in 126-8. Two farmsteads with sheltering groups of trees. Rice terraces among big boulders. About 6km west of Hap Shui and about 41 km south west south of Loting. July 1932. (RLP Photo No. 126-9)



Fig. 147. Still farther up the same valley. A farmyard with grain drying; a bark roof at left weighted with stones. Rice in valley bottom and far up opposite slope. Much bamboo higher. About 7km west of Hap Shui and about 41 km south west south of Loting. July 1932. (RLP Photo No. 126-10)



Fig. 148. Soil profile exposed in fresh road cut; brownish gray  $\pm$  20-30cm; medium brown below. Sweet potatoes above on old terrace surface. About 8km west of Hap Shui and about 42km south west south of Loting. July 1932. (RLP Photo No. 126-11)



Fig. 149. A fresh road cut in a forest soil, showing gray soil  $\pm$  20-40cm; light yellowish brown below. About 8km west of Hap Shui and about 42km south west south of Loting. July 1932. (RLP Photo No. 126-12)





Fig. 150. Forest soil, brown to grayish brown  
 ± 40cm, brownish yellow, friable below Professor  
 Hoffman's hand. About 8km west of Hap Shui and about  
 42km south west south of Loting. July 1932.  
 (RLP Photo No. 127-1)



Fig. 151. Zig-zag paths on distant hill, of the  
 type used in Cunninghamia plantations. About 8km west  
 of Hap Shui and about 42km south west south of Loting.  
 July 1932. (RLP Photo No. 127-2)



Fig. 152. Fresh road cut in soil at the pass. Tea  
 bushes above. About 8km west of Hap Shui and about 42km  
 south west south of Loting. July 1932. (RLP Photo No.127-3)



Fig. 153. Down the road from the pass near 127-3. Tea bushes on the slopes. High steep grass covered hills in the extreme distance. Soil medium gray to  $\pm$  20-30cm, subsoil yellowish and reddish streaked. About 8km west of Hap Shui and about 42km south west south of Loting. July 1932. (RLP Photo No. 127-4)



Fig. 154. The irregular, upper portion of the Chenpai Valley. The stream is in the center, the new road at the right. Irrigated rice and upland terraces are at the left, beyond, and the high Chienpai mountains in the extreme distance. July 1932. (RLP Photo No. 127-5)



Fig. 155. The steep slopes on the south-facing slope of the upper Chienpai valley, in the same direction as Fig. 154 but slightly farther down the valley. Cassava is planted on the steep slopes above the road. July 1932. (RLP Photo No. 127-6)



Fig. 156. Looking up a side valley planted to rice. On the slopes there are some tea bushes, but no extensive cultivation. A farm stead in the distance at the base of the mountain.  $\pm$  12km south-west of Hap Shui toward Chien Pai. July 1932. (RLP Photo No. 127-7)



Fig. 157. Applying lime and liquid manure to sweet potatoes at time of planting. The soil is grey and apparently poorly drained, hence the very high ridges on which the planting is done. The distant mountains are mostly grassy, though where the pines have a chance, they do well.  $\pm$  12km. S.W. of Hap Shui toward Chien Pai. July 1932. (RLP Photo No. 127-8)



Fig. 158. A small roadside village in the midst of the usual rice terraces. The distant mountain slope is entirely uncultivated.  $\pm$  13km. south west of Hap Shui toward Chien Pai. July 1932. (RLP Photo No. 127-9)





Fig. 159. Valley floor planted to rice. The hills are neither cultivated nor do they carry any considerable forest. A waterfall is visible at the upper left of the mountain slope.  $\pm$  13km. south west of Hap Shui toward Chien Pai. July 1932. (RLP Photo No. 127-10)



Fig. 160. A fresh road cut through a terrace planted to sweet potatoes. Additional small terraces above in the background. The soil is greyish brown to a depth of 15 to 30cms. The sub-soil is red. Mr. Hoh K.  $\pm$  14kms. south west of Hap Shui, Chien Pai. July 1932.

(RLP Photo No. 127-11)



Fig. 161. A section of the soil similar to the last, showing rapid and very deep erosion. Professor Hoffman.  $\pm$  14kms. south west of Hap Shui toward Chien Pai. July 1932. (RLP Photo No. 127-12)



Fig. 162. A farmstead at the base of a well watered hill. The terraces are planted to rice and corn. The old road down the valley passes this side of the buildings.  $\pm$  5kms. east of Chien Pai. July 1932. (RLP Photo No. 128-2)



Fig. 163. New road down the valley showing how easily the soils slide.  $\pm$  5km east of Chien Pai. July 1932. (RLP Photo No. 128-3)



Fig. 164. An intensively terraced alluvial fan and lower mountain slope. Terraces are all planted to rice. Part of the mountain slopes are effectively used by planting of Cunninghamia.  $\pm$  3km east of Chien Pai. July 1932. (RLP Photo No. 128-4)



Fig. 165. Rice on narrow terraces, with some of the nearer ones at the right planted to peanuts, sweet potatoes and corn. The most distant terraced hill is probably planted to unirrigated crops. A bed of the old road may be seen in the centre foreground passing along the terraces. † 2.5kms. east of Chien Pai. July 1932. (RLP Photo No. 128-5)



Fig. 166. Looking down the valley from a station farther west. Rice and some other crops are planted on the terraced fields. † 2kms. east of Chien Pai. July 1932. (RLP Photo No. 128-6)



Fig. 167. High mountains south of Chien Pai seen through clouds from our camp at Chien Pai school. Chien Pai. July 1932. (RLP Photo No. 128-7)





Fig. 168. A farm stead near Chien Pai. Rice is planted on the terraces in front of the buildings, with fruit trees and bamboo beyond, and pines on the hills in the distance. Chien Pai. July 1932.  
(RLP Photo No. 128-8)



Fig. 169. A steeply terraced hill with recent and older erosion. Canarium tree on the slope at the right. In the valley bottom are rice seed beds. On the terraces are cassava, peanuts and some other upland crops. The soil is red. Foot hills south of Chien Pai. July 1932.  
(RLP Photo No. 128-9)



Fig. 170. Applying lime and liquid manure to a sweet potato field at planting time. The soil is brownish grey; in the distance it is red on the unirrigated terraces. Foot hills south of Chien Pai. July 1932.  
(RLP Photo No. 128-10)



Fig. 171. Looking westward up the mountain valley from the same station from which 128-10 was taken. In the distance are rice terraces in the valley, with some good plantings of pine on the lower slopes of the mountain. Messers. Wood and Pan. Chien Pai. July 1932.  
(RLP Photo No. 128-11)



Fig. 172. Looking back toward the field shown in 128-10 which lies just below "A". Irrigated rice occupies most of the terraces. "B" indicates a small hut in which compost or liquid manure is prepared and kept until applied to the fields. North facing slope of Chien Pai valley. Chien Pai. July 1932. (RLP Photo No. 128-12)



Fig. 173. Chien Pai plain which lies west of Chien Pai village, taken from a station about half way up the mountain slope. The lower terraces on the slopes are mostly irrigated. The terraced hills are largely planted to unirrigated or upland crops. Chien Pai. July 1932.  
(RLP Photo No. 129-1)



Fig. 174. Looking down the valley to the west of Chien Pai from the mountain peak to the east of the pass. This is the valley down which the main highway is to go toward Shun Yu, and along which a number of photographs were taken, from No. 131-9 to No. 133-4. The upland slopes which are visible are largely occupied by grass. Deep down in the valley, in the foreground, are some plantings of cassava around a small farmstead. This photograph is looking in the opposite direction from 132-12, which latter photograph was taken from the far westerly end of this valley, looking back toward the high mountain on the sky line from which this photo, No. 129-2, was taken. Chien Pai. July 1932. (RLP Photo No. 129-2)



Fig. 175. Zig-zag trails and heaps of rocks indicating a former intensive cultivation on slopes that are occupied now only by grass and used for pasture. This view is at the head of the valley shown in 129-2. Soil is friable, finely granular, medium grey to about 20cms. Below that it is a light brownish yellow. Erosion has commenced in the steeper ravines in the centre distances. High mountains south of Chien Pai. July 1932. (RLP Photo No. 129-3)



Fig. 176. Cattle huts, a spring from which cattle obtain water and wallows used by water buffalo. In the distance is seen the same uncultivated land as shown in No. 129-3. High mountains south of Chien Pai. July 1932. (RLP Photo No. 129-4)





Fig. 177. A small "valley" among the high peaks at the left of those shown in 129-3. There are remains of old huts and indications of previous cultivation. The entire region is used only for pasture except for some graves. Two of these recently cleaned are indicated by light splotches. High mountains south of Chien Pai. Chien Pai. July 1932. (RLP Photo No. 129-5)



Fig. 178. High mountains looking south east, in the opposite direction from those shown in 129-5. There are some new graves and remains of previous cultivation. In the extreme distance at the right and centre there are still quite heavy forests on the mountain tops as well as in the valleys, indicating that all these grassy slopes were undoubtedly previously in the forest. The slopes in the foreground are covered partly with Imperata grass and sedges. The soil is dark grey to about 5cms, below that it is a light yellow friable clay loam, from schists and granites. High mountains south of Chien Pai. Chien Pai. July 1932.

(RLP Photo No. 129-6)



Fig. 179. Chien Pai valley from the top of the mountains shown through the cloud in 128-7. Our quarters at the Chien Pai school are just below "X". In the foreground are the bare grassy hills relatively unutilized. Chien Pai. July 1932.

(RLP Photo No. 129-7)



Fig. 180. Looking up the Chien Pai valley to the right of, but partly overlapping, the view shown in 129-7. The road from Loting comes down this valley, passing to the left in the middle distance. Taken from the high mountains to the South of Chien Pai. Chien Pai. July 1932. (RLP Photo No. 129-8)



Fig. 181. Sharp, grass covered peaks near and similar to those shown in 129-5. High mountains south of Chien Pai valley. Chien Pai. July 1932. (RLP Photo No. 129-9)



Fig. 182. Grassy slopes, previously cultivated. The station from which this view was taken is to the right and below, from which 129-7 was taken. This view is looking north toward Chien Pai Valley. Our school head quarters at Chien Pai are just below "X" and "around the corner." Chien Pai. July 1932. (RLP Photo No. 129-10)



Fig. 183. The opposite or north west facing wall of the valley to that shown in 129-10. Our trail down the valley is visible just above the plantation of trees at the lower left. High mountains south of Chien Pai. Chien Pai. July 1932. (RLP Photo No. 129-11)



Fig. 184. Central portion of the side valley lying between the east facing wall shown in 129-10 and the north west facing wall shown in 129-11. The main Chien Pai valley is in the distance to the north east. Chien Pai. July 1932. (RLP Photo No. 129-12)



Fig. 185. Looking to the south west, down the valley, in the opposite direction from the one shown in 129-10, 11,12. There are apparent the evidences of former cultivation on the slopes. A few small pines and firs have been planted in the foreground. High mountains south of Chien Pai valley. Chien Pai. July 1932.(RLP Photo No.130-1)





Fig. 186. Soil profile along the trail at the pass, at the upper end of the valley shown in 129-10, 11 and 12. The surface soil is grass covered and dark to about 5-10 cms. Below is a light yellowish clay loam sub-soil. Chien Pai. July 1932. (RLP Photo No. 130-2)



Fig. 187. Fuel grass gatherers along the trail just below that shown in 130-2. In the far distance are visible the same grassy slopes as in 129-10 and 12. High mountains south of Chien Pai. Chien Pai. July 1932. (RLP Photo No. 130-3)



Fig. 188. The same valley as shown in 130-3 and 129-12. There are old zig-zag trails and some planted trees. The main Chien Pai valley is in the distance, our camp being located below "X". See 130-6 for a detail of the slope which lies between "A" and "C". High mountains south of Chien Pai valley. Chien Pai. July 1932. (RLP Photo No. 130-4)



Fig. 189. A plantation of Cunninghamia along the trail. Farther down the same valley as shown in 130-3 and 4. For comparison of the size of the trees compare Messrs. Pan and Wood standing on the trail at the left. Mountains south of Chien Pai valley. Chien Pai. July 1932. (RLP Photo No. 130-5)



Fig. 190. Looking across toward the east facing slope of the valley shown in 129-12 and 130-3,4. This slope is the one shown between letters "A" and "C" of 130-4. Note the zig-zag trails on the higher slope and the clearing in the right center with similar trails. Below is a farm stead with the highest elevation irrigated rice in this locality. There is a considerable number of Cunninghamia trees planted in this locality, including nurseries of young trees. Mountains south of Chien Pai valley. Chien Pai. July 1932. (RLP Photo No. 130-6)



Fig. 191. Mature Cunninghamia on terrace edges. Rice is on the terraces in the open. Other crops are planted in the shade of the trees. This is the same hill and distant clearing as shown in 130-6, but from a lower station. Mountains south of Chien Pai valley. Chien Pai. July 1932. (RLP Photo No. 130-7)



Fig. 192. Plantings of pine and Cunninghamia, old and young, on the opposite or west facing slope of the valley to that shown in 130-7. Far above in the distance are visible some cultivated terraced slopes. Mountains south of Chien Pai valley. Chien Pai. July 1932.  
(RLP Photo No. 130-8)



Fig. 193. A big pine tree standing on the edge of rice terraces. Chien Pai valley in the distance to the north. Chien Pai. July 1932. (RLP Photo No. 130-9)



Fig. 194. Rice terraces among boulders on the lower valley slopes. Looking south up the same valley as in photographs 129-12, 130-3 - 130-9, inclusive. Some of the slopes show good forests; high above only grass. Mountains south of Chien Pai. Chien Pai. July 1932.  
(RLP Photo No. 130-10)





Fig. 195. Looking across the Chien Pai valley to the north east from near the station where 130-10 was taken. Big granite boulders are in the stream among rice terraces. Across the valley some of the lower slopes are cultivated while others are not. Chien Pai. July 1932. (RLP Photo No. 130-11)



Fig. 196. A load of sawn lumber being carried down the trail. This station is near those shown in 130-11 and gives an idea of the paved trail and the covering of the slopes where no efforts have been made to utilize them either for forestry or annual crops. Chien Pai. July 1932. (RLP Photo No. 130-12)



Fig. 197. A village down the main valley west of Chien Pai. Rice fields in the foreground; excellent big pines on the hill behind the village. Chien Pai. July 1932. (RLP Photo No. 131-1)



Fig. 198. A lumber yard on the new road west of Chien Pai. The soils in this locality are of a deep red color and slide seriously. † 2kms west of Chien Pai. July 1932. (RLP Photo No. 131-2)



Fig. 199. A fresh road cut through a rice field, showing about 30cms of grey soil; the sub-soil below is a mottled red. † 2kms. west of Chien Pai. Chien Pai. July 1932. (RLP Photo No. 131-3)



Fig. 200. A road cut through a rice field, the face of the cut having recently caved away, showing about 30 cms of grey soil; the sub-soil is red, a quartz vein indicates that this is a residual soil deeply weathered. † 2kms west of Chien Pai. Chien Pai. July 1932. (RLP Photo No. 131-4)



Fig. 201. A terraced valley planted to irrigated rice. A single tall Cunninghamia on the horizon, at the right.  $\pm 2\frac{1}{2}$  kms west of Chien Pai. Chien Pai. July 1932. (RLP Photo No. 131-5)



Fig. 202. A recent road cut through a sweet potato field. The face of the cut has caved away somewhat, showing about 30 cm of grey soil, below which the sub-soil is whitish.  $\pm 2\frac{1}{2}$  km west of Chien Pai. Chien Pai. July 1932. (RLP Photo No. 131-6)



Fig. 203. Dark brown surface soil of brown sub-soil. A colluvial slope from schistous rocks. Exposure in a road cut near the top of a pass  $\pm 2\frac{1}{2}$  km west of Chien Pai. Chien Pai. July 1932. (RLP Photo No. 131-7)





Fig. 204. Landslide topography on a south west facing slope just south of the pass. This locality lies down the valley below the slopes shown in 129-3 and the lower right end portion of the view shown in 129-2.  $\pm 2\frac{1}{2}$  km west of Chien Pai. Chien Pai. July 1932. (RLP Photo No. 131-9)



Fig. 205. Our luggage carriers on the trail in the distance beneath the plantation of pines.  $\pm 3$  km west of Chine Pai. Chien Pai. July 1932. (RLP Photo No. 131-11)



Fig. 206. Many pines and Cunninghamia on steep hill slopes. The lower valley slopes are terraced for rice. On the hills on the horizon at the left is some serious erosion.  $\pm 3$  km west of Chien Pai. Chien Pai. July 1932. (RLP Photo No. 131-12)



Fig. 207. A farmstead surrounded by rice on the terraces and some fruit trees. In this view is shown the first camphor tree seen for a long time. The upper slopes of the hill are effectively utilized either for irrigated or upland crops or for plantation of forest trees.  $\pm$  4km south west of Chien Pai toward Tungchen. Chien Pai. July 1932. (RLP Photo No. 132-1)



Fig. 208. A new road running along above the stream at the right. There is some rice on terraces, but as a whole the hills are not effectively used for timber production.  $\pm$  5km west of Chien Pai toward Tungchan. Chine Pai. July 1932. (RLP Photo No. 132-2)



Fig. 209. A broader portion of valley floor planted to rice. The hills in this locality show no effects of afforestation.  $\pm$  5km west of Chien Pai toward Tungchen. Chien Pai. July 1932. (RLP Photo No. 132-3)



Fig. 210. A young Cunninghamia plantation on a north facing slope. The terraces in the foreground are planted to rice.  $\pm$  5km south west of Chien Pai toward Tungchen. Chien Pai. July 1932. (RLP Photo No. 132-4)



Fig. 211. Brown soil underlain by a deep red colored sub-soil, residual apparently from schists. Messrs. Hoffman and Hoh K. at the right.  $\pm$  5 $\frac{1}{2}$ km west of Chien Pai toward Tungchen. July 1932. (RLP Photo No. 132-6)



Fig. 212. Rice fields ready for harvest. In the distance across the stream harvesting is in progress, the smoke indicating that the straw is burnt almost immediately after threshing in the field. The rice soil is grey. The hills do not show effective utilization.  $\pm$  6km west of Chien Pai toward Tungchen. Chien Pai. July 1932. (RLP Photo No. 132-7)





Fig. 213. A bridge of the old highway down the valley. Hills are becoming lower and the country more open. As usual, rice is the main crop on the terraces. Messrs. Hoh K. and Hoffman on opposite ends of the ridge.  $\pm$  7km south west of Chien Pai toward Tungchen. Chien Pai. July 1932.  
(RLP Photo No. 132-8)



Fig. 214. In this seriously eroded road-side ditch, the exposed rice field profile shows a dark grey soil, with yellowish brown below, underlain by grey. On the distant hill slope above the rice terraces, the soil is eroding.  $\pm$  9km west of Chien Pai toward Tungchen. Chien Pai. July 1932. (RLP Photo No. 132-9)



Fig. 215. The bare hill behind the temple has been terraced and cultivated, but is now relatively unutilized. The foreground terraces are planted to rice.  $\pm$  10km west of Chien Pai toward Tungchen. Chien Pai. July 1932.  
(RLP Photo No. 132-11)



Fig. 216. Looking back up the valley to the east north east. The high mountain on the horizon in the centre is the one shown in Nos. 129-2,3,4 and 10. Along this valley have been taken Nos. 131-9 to 12 and 132-1 to 11, inclusive.  $\pm 10\frac{1}{2}$  kms west of Chien Pai toward Tungchen. Chien Pai. July 1932. (RLP Photo No. 132-12)



Fig. 217. First and northern part of an entrenched meander, looking east north east up the Sufangtien valley toward the same mountain as shown in 132-12.  $\pm 11$  km west of Chien Pai. July 1932. (RLP Photo No. 133-1)



Fig. 218. First and second portions of the same entrenched meander. In the near foreground is a very young plantation of Cunninghamia interplanted with young cassava as a nurse crop.  $\pm 11$  km west of Chien Pai. July 1932. (RLP Photo No. 133-2)



Fig. 219,220. Third and fourth parts of the same entrenched meander as shown in Nos. 133-1 and 2. In the foreground at the right and left are shown young Cunninghamia plantations. Below at the right is farmstead and between that and the river are terraced rice fields. km south west of Chien Pai toward Tungchen.  $\pm$  11 km west of Chien Pai. July 1932. (RLP Photo No. 133-3 and 133-4)



Fig. 221. A soil profile showing a deep red sub-soil along the new road. Ferns and pines are above this profile on the right. The narrow valley in the distance is planted to rice.  $\pm$  11 km south west of Chien Pai toward Tungchen. Chien Pai. July 1932. (RLP Photo No. 133-6)



Fig. 222. The valley above Pakshek. An old charcoal kiln in the plantations of mixed cassava and Cunninghamia on the near slopes. Cassava is here used extensively as nurse crop for Cunninghamia. As usual rice occupies the valley floor. Near Pakshek.  $\pm$  10km east of Tungchen. July 1932. (RLP Photo No. 133-7)





Fig. 223. A big farmstead surrounded by some bamboos and lying between the rice fields below and narrow unirrigated terraces above. Pakshek.  $\pm$  10km east of Tungchen. July 1932. (RLP Photo No. 133-9)



Fig. 224. Dark red soil material exposed in a recent road cut. Ferns and a few pines are growing in this soil. Pakshek.  $\pm$  10km east of Tungchen. July 1932. (RLP Photo No. 133-10)



Fig. 225. Lumber for shipment, at the end of the auto bus line, Shih Lung, Pak Shek. July 1932. (RLP Photo No. 133-11)



Fig. 226. Looking south west toward Shun Yü from Ta Ling Tang, showing a relatively good forest covering on the nearer hills. Farther, in the distance, the hills are less and less effectively used. West of Pakshek and  $\pm$  8km east of Tungchen. July 1932. (RLP Photo No. 133-12)



Fig. 227. The river valley of west fork at Shun Yü. Rice fields in the foreground. A water wheel for irrigating rice is on the river bank. Large bamboos are on the far shore of the river. Lam family village in the distance. Shun Yü. July 1932. (RLP Photo No. 134-1)



Fig. 228. Looking south west from the south wall at Shun Yü, showing rice fields on the alluvial plain. Shun Yü. July 1932. (RLP Photo No. 134-4)



Fig. 229. Looking from the town wall across the east fork of the river and its narrow alluvial plain. The red soils on the hill east of the river are eroded seriously. Shun Yü. July 1932. (RLP Photo No. 134-11)



Fig. 230. Soy beans planted in broad beds on a grey sandy loam. On the hill in the distance rice straw is drying. Near the hot springs.  $\pm$  7km north west of Shun Yü. July 1932. (RLP Photo No. 135-3).



Fig. 231. Looking north, across the west fork river valley from the hill shown at the extreme right on the horizon in No. 135-3. The hot springs pavilion is shown at the extreme right near the river. The terraces are planted to rice, taro and some hemp. The distant mountains are not eroded seriously.  $\pm$  7km north west of Shun Yü. July 1932. (RLP Photo No. 135-4)





Fig. 232. A young seedling pine plantation on the hill at the left. A reservoir lies below and rice fields in the distance beyond. The far hills show some erosion. The soils near by are a light yellowish-white sandy clay. This view is looking south east, in the opposite direction from the one shown in 135-4.  $\pm$  7km north west of Shun Yu. July 1932. (RLP Photo No. 135-5)



Fig. 233. A narrow valley planted to rice and soybeans. A number of the houses have fish ponds near by. At the right centre are a number of terraces now uncultivated. This view is looking south west from near the same station as shown in 135-5. The distant hills are almost uneroded.  $\pm$  7km north west of Shun Yu. July 1932. (RLP Photo No. 135-6)



Fig. 234. Harvesting and drying rice. Note the rectangular wooden box in which the rice is threshed immediately upon cutting. This is just beyond the taro patch in the foreground. Near the bamboos in the distance the threshed rice and the straw are being dried. This view is a detail of that shown at the left distance in 135-4.  $\pm$  7km north west of Shun Yu. July 1932. (RLP Photo No. 135-7)



Fig. 235. Looking south down the valley of the west fork river from the temple pavilion near the hot springs.  $\pm$  7km north west of Shun Yu. July 1932. (RLP Photo No. 135-8)



Fig. 236. Compost preparation floor with a thatched cover over a heap of compost. This compost is made up of weathered pond mud mixed with pig manure, night soil and rice chaff. Beyond the compost heap, toward the figures, is rice drying. The compost is stored for two to three months before use, the length of the time depending on the size of the pile. One km north of Shun Yu. July 1932. (RLP Photo No. 136-8)



Fig. 237. Drying rice and rice straw. In the distance are seriously eroded slopes of the hill. About one km north of Shun Yu. Shun Yu. July 1932. (RLP Photo No. 136-9)



Fig. 238. The erosion shown in the foreground started from the construction of a grave plot and the subsequent repeated cleanings which are done annually or oftener. Some of the bare soil is covered with a low close-lying growth, probably algae, which develops during the rainy season. The soil is light yellowish brown sandy loam. About one km north of Shun Yü. July 1932. (RLP Photo No. 136-10)



Fig. 239. The distant hill in the centre is a red soil material eroded especially around the base where the drainage and flood water ditch passes from the left of this view around the front of the hill and on to the right. The valley floor is occupied by rice fields. The hills in places have been planted to young pine  $\pm 1\frac{1}{2}$  km north of Shun Yü. July 1932. (RLP Photo No. 136-11)



Fig. 240. Looking north up the east fork of the river from the same station from which No. 136-11 was taken. The hill in the foreground has been planted to pines which have been very severely trimmed in order to provide fuel. The river bed itself is to a great extent filled with sand eroded from the hills.  $\pm 1\frac{1}{2}$  km north of Shun Yü. July 1932. (RLP Photo No. 136-12)





Fig. 241. A detail of the view shown in 136-11. Rice is planted on the valley floor and in the foreground is a flood water ditch following around the base of the hill to keep the stream from damaging the rice field. In the distance is the same eroded hill which was shown in the previous view.  $1\frac{1}{2}$ km north of Shun Yü. July 1932. (RLP Photo No. 137-1)



Fig. 242. A detail of the eroded face of the hill shown in Nos. 136-11 and 137-1. The undisturbed surface of the eroded face is quite red from the soil and sub-soil material washed down from above. After digging this away, as shown to the left of the peak, the true color of the material deep below the surface is a mottled bluish yellow and purplish red.  $1\frac{1}{2}$ km north of Shun Yü. July 1932. (RLP Photo NO.137-2)



Fig. 243. Looking north west up the west fork of the river. On the hill alopes at the right there are pines on the upper portion and bamboo farther down. In the plain most of the fields are either in standing rice ready to be harvested or already plowed for the second crop. There is one field of taro. The soil is a light greyish brown loam to clayloam. In the distance can be seen the very shallow river bed. 1 km north west of Shun Yü. July 1932. (RLP Photo No. 137-4)



Fig. 244. Looking south west across the same river valley from about the same point as that shown in 137-4. In the foreground on the slope are some pines. On the plain near the hill the fields are either in rice ready to be harvested or in rice seed beds. Near the river bank are some fields of beans which will be followed by a crop of sweet potatoes; along the river bank are clumps of bamboo. The fields on the opposite side of the river are utilized in about the same way. 1 km north west of Shun Yü. July 1932.

(RLP Photo No. 137-5)



Fig. 245. Shun Yü town taken from about the same site as where 137-4 and 5 were taken. The lands in the other views are planted largely to rice. 1 km north west of Shun Yü. July 1932. (RLP Photo No. 137-6)



Fig. 246. A locally made wooden "wheel hoe" used for interculturing young soy beans. The broad iron blade is barely visible below and behind the wheels. 1 km west of Shun Yü. July 1932. (RLP Photo No. 138-1)



Fig. 247. Using the wheel hoe in the soy bean field. This cultivation is repeated every ten days until the beans close in. See No. 138-1 for a detail of this hoe. 1 km west of Shun Yü. July 1932. (RLP Photo No. 138-2)



Fig. 248. Grassy hills in places seriously eroding and with rice fields in the lower part of the valleys. In the foreground is a hill of deeply weathered granitic material. About 1 km south of Shun Yü along the Kochou road.

July 1932. (RLP Photo No. 138-7)



249.

Fig. Bare rolling hills with a narrow strip of cultivated rice in the depression. Looking south west, away from the river, from about the same point from which No. 138-7 was taken. The soil in the foreground is a reddish brown gravelly clay loam. About 1 km south of Shun Yü along the Kochou road. July 1932. (RLP Photo No. 138-8)





Fig. 250. A soil profile exposed on the road-side, showing about 15cms of greyish brown sandy loam, below that a yellowish brown clay loam to about 150cms. There are no sharp horizon distinctions. In places, on the face of the cut, a growth of lichens or algae may be seen, particularly at the right below and above at the left. The hill slope is covered with very short grass. About 1 km south of Shun Yü. July 1932.  
(RLP Photo No. 138-9)



Fig. 251. The hill slope above the Kochou road, showing the erosion working back from the road cutting and from the various graves scattered over the hill slope. For a scale note the figure standing in the shade near the small tree on the road. About 1.5km south of Shun Yü on the Kochou road. July 1932. (RLP Photo No. 138-10)



Fig. 252. A somewhat more effectively used valley in a similar country to that shown in Nos 138-7 to 10 inclusive. In the valley bottom are rice fields. In the foreground peanuts. Beyond at the right are hedges of Pandan and beyond the hamboo clumps around the village. Along the base of the hill at the left is considerable erosion. About 2½km south west of Shun Yü along the Kochou road. July 1932.  
(RLP Photo No. 138-12)



Fig. 253. Brownish grey soil 30 or 40cm deep and a brown soil to about 60cm; below that brownish red and yellow with abundant small concretions. Note on the road surface in the near foreground numerous concretions of the same sort.  $3\frac{1}{2}$  km south of Shun Yü on the Kochou Road. July 1932. (RLP Photo No. 139-1)



Fig. 254. A soy bean field on a grey sandy loam with a red sub-soil. The figure in the distance is applying compost fertilizer. The field has been artificially levelled to make a flat topped hill. About 4km south of Shun Yü on the Kochou Road. July 1932. (RLP Photo No. 139-2)



Fig. 255. The main river flood plain of a brown sandy loam soil with a red sub-soil. These fields have been planted to rice and soy beans. In the distance along the river bank are clumps of bamboo. For a profile of this soil at the river bank see No. 139-4.  $\pm$  4km south of Shun Yü along the Kochou Road. July 1932. (RLP Photo No. 139-3)



Fig. 256. A river cut into the old flood plain, showing about 50cms of greyish brown fine sandy loam underlain for at least four metres by a brownish red sub-soil, apparently a clay loam. Compare this view with No. 139-3.  $\pm 4$ km south of Shun Yü on the Kochou road. July 1932. (RLP Photo No. 139-4)



Fig. 258. A farm stead at the edge of the valley. In the foreground is a rice field being prepared for the second planting. Beyond at the right is a compost heap covered with a grass thatch. Remains of Pandan hedge are beyond. The farm buildings are on the slope of the hill surrounded by bamboo. The hills beyond are of deeply weathered granites.  $\pm 5$ km south of Shun Yü on the Kochou road. July 1932. (RLP Photo No. 139-6)



Fig. 257. A detail of the same farm as shown in 139-6. In the foreground is a peanut field. On the dry floor are heaps of compost being prepared for the fields. The building is a combined latrine and compost preparation house.  $\pm 5$ km south of Shun Yü on the Kochou road. July 1932. (RLP Photo No. 139-5)





Fig. 259. Typical hill country along the road between Shun Yü and Kochou. The soils are greyish brown with iron concretions. The sub-soil is deep, brownish red in color. The few trees that are permitted to grow, indicate that these hills would produce good timber and fuel if they were given a chance. In the valley at the left a little rice is being grown. South west of Wankou.  $\pm 7$ km south of Shun Yü. (RLP Photo No. 139-8)



Fig. 260. The valley of hills along the south edge of the Kochou plain. Rice fields surround the clumps of trees which shelter the villages. Graves are on the almost treeless hills. The soil in the foreground is a gravelly loam from reddish schists. This view is looking south east, about 1 km south west of Kochou (Mauming). July 1932. (RLP Photo No. 140-1)



Fig. 261. Looking north east, over a bend in the river toward Kochou town and the hills beyond. At the foot of the hill at the right of the river is a night soil depot where fertilizers are prepared. For a detail see No. 140-4. Kochou (Mauming). July 1932. (RLP Photo No. 140-2)



Fig. 262. Plain of brown fine sandy loam, lying to the south of Kochou. Most of the valley is planted to rice. The hills in the distance, particularly at the right, are eroding considerably. 1 km south of Kochou (Mauming). July 1932. (RLP Photo No. 140-5)



Fig. 263. Low hill of deeply weathered granite. The soil is gravelly with quartzitic fragments. The soil in the distance near the car and beyond is a sandy loam with much limonite cemented hard-pan, though none of this seems to be in place. About 25km south east of Kochou (Mauming) along the Shuitung road. July 1932. (RLP Photo No. 140-7)



Fig. 264. A view in the opposite direction from the same hill as shown in No. 140-7. The gravelly nature of the soil in the foreground is clearly visible through the very scant grass. This gravelly soil is not cultivated, being evidently too poor. It would, however, produce pines some of which are visible in the distance. In the lowlands beyond are seen rice fields. On the horizon is a village. About 25km south east of Kochou (Mauming) along the Shuitung road. July 1932. (RLP Photo No. 140-8)



Fig. 265. A small valley producing quite a good crop of rice. Bare hill in the distance, occupied mostly by graves. In this part of the country it is a local custom not to have trees near the graves. Visible over the top of the hill is a good stand of pines, showing what the relatively poor soils will do in producing trees. The highway to Shuitung is visible to the right in the distance. South east of Kochou (Mauming) about 23km. July 1932. (RLP Photo No. 140-9)



Fig. 266. A field of black soil occupying a depression in this region of slightly undulating soils. The first crop of the season, rice, has been harvested and the stubble is being plowed for sweet potato. The soil is said to be very poor. See profile No. 354. About 20km south east of Kochou (Mauming) along the Shuitung road. July 1932.(RLP Photo No.140-10)



Fig. 267. Iron cemented hardpan exposed in a road cut. The pick indicates the original soil surface. The soil is a gravelly sandy loam about 15cm deep; below this is a layer of broken limonite fragments, extending from 15 to 40cm. Below this is a reddish clay loam from 40 to 60cm. The lowest layer exposed is a laminated iron cement layer at 60cm. About 15km south east on the Kochou road. July 1932.(RLP Photo No.140-11)





Fig. 268. A view of the extremely poor upland and valley soils that occupy a considerable area along the Shuitung road. In the foreground there are some graves, marked only by the broken soil surface and large quantity of broken iron-cemented chunks of quartz sand hardpan. In the distance the valley soils are a grey sandy loam. The distant hills are quite desolate and entirely unproductive. About 14km south east of Kochou (Mauming) July 1932. (RLP Photo No. 141-1)



Fig. 269. The road cut through the grey sandy loam covering this hillside. The pick is in the broken iron-cemented layer which lies about 60cm below the surface. This layer is from 20 to 40cm thick and is underlain by a light yellow and red splotched non-lateritic granitic sand. At the present time this soil is quite unproductive, but the few pines in the distance indicate that it might be the source of considerable fuel and timber. About 14km south east of Kochou. July 1932. (RLP Photo No. 141-2)



Fig. 270. The soils in the foreground of this view are slightly elevated and are a light brown loam to clay loam with many small iron concretions and quartz particles on the surface. In the distance at the foot of the hills are some rice fields. The hills in the background are the ones surrounding the Kochou valley and are on the opposite side of the hills shown in 140-1. About 5km south east of Kochou (Mauming) on the Shuitung road. July 1932. (RLP Photo No. 141-3)



Fig. 271. The main trail leading into Kochou from the east, showing in the distance a seriously eroded hill. Almost entirely barren of any vegetation. The small valley below the trail at the left used to provide rice, but the fields have been ruined because of the excessive over-wash from the hill-side erosion. On the trail in the foreground are carriers on their way to market with tungkua melons. Kochou. July 1932. (RLP Photo No. 141-5)



Fig. 272. A small valley in the hills to the south east of Kochou. The valley produces a great deal of truck in addition to rice. In the foreground the hills are stony loam used mostly for graves. There is some serious erosion near by, but it is not apparent in this view. However, the hills beyond the valley are conspicuously eroded. If trees were planted on them there would be a prevention of this erosion as well as additional source of fuel for the town. This view was taken from near the place from which No. 141-6 was taken. Kochou. July 1932. (RLP Photo No. 141-7)



Fig. 273. A very seriously eroded hill a few km east of Kochou in the same locality as shown in Nos. 141-4 - 7 inclusive. To get a good idea of the seriousness of this erosion, note the man standing at the edge of the shadow just to the left of the main ravine. July 1932. (RLP Photo No. 141-8)



Fig. 274. A slightly undulating agricultural region located about 30km south east of Kochou, near the village of Nam Sing. This is the locality where was located a very large agricultural company since bankrupt. In this view, in the foreground, the soil is quite gravelly with many angular red concretions. The agricultural soil behind the men is much finer textured and a medium brownish grey about 20cm deep. The subsoil is light colored with reddish spots. In the distance may be seen soy beans, rice, truck and sugar cane, all of which seem to do reasonably well. July 1932. (RLP Photo No. 141-9)



Fig. 275. A wheel barrow of pig manure on the way to the field. Soil here is a grayish brown with red concretions. Namsing. July 1932. (RLP Photo No. 141-10)



Fig. 276. Hemp and rice growing on recent alluvial soils along the Muiluk Wangpo road, a few kilometres east of the river at Wangpo. July 1932. (RLP Photo No. 142-5)





Fig. 277. An estuary near Wangpo. Submerged land with heavy swamp soils beyond. July 1932. (RLP Photo No. 142-6)



Fig. 278. Rice fields on a grey fine sandy loam (see profile 355). In the distance is visible a portion of the village of Wangpo. The group of the villagers at the right are watching Professor Hoffman collecting insects. 25 km south west of Muiluk. July 1932. (RLP Photo No. 142-9)



Fig. 279. Reddish brown deep sandy loam about 9kms south west of Muiluk. At the time of taking the photograph this soil was bare, but it is evident it had previously been cultivated. Nearby, at the left, cassava and beans were seen growing. This is the locality where a large agricultural company had been proposed. It is true there is much valuable land here, but the productivity is undoubtedly only moderate at best. July 1932.

(RLP Photo No. 142-11)



Fig. 280. A roadside barrow pit in deeply, weathered rock. The soil is a gravelly loam, the first meters depth of which is darker in color. As is apparent in the photograph, there is a gradual transition downwards to red splotched white kaolin. In this kaolin are numerous quartz grains. Professor Wood at the right. About 1 km south east of Muiluk. July 1932. (RLP Photo No. 142-12)



Fig. 281. A small valley planted to rice and taro. The uplands are the usual brownish red sandy loam so common in this region. Much of this upland is used for graves, which in places here are very thick. On the horizon at the right is a grove of trees in which is held the hemp market (shown in photographs Nos. 142-3,4). July 1932. (RLP Photo No. 143-2)



Fig. 282. A brownish red upland sandy loam 2kms south of Muiluk. A number of graves are visible in this view. The erosion which is apparent has undoubtedly been the result of the road, for along the cart tracks the erosion so often commences. July 1932. (RLP Photo No. 143-3)



Fig. 283. A peanut drying floor on a compact reddish loam, which is coarse and sandy. Peanuts are drying in the foreground. In the distance are others in sacks. About 4km south of Muiluk. July 1932. (RLP Photo No. 143-4)



Fig. 285. Along the lower course of the rivers, there is great difficulty from floods during the rainy season. This view taken from the north gate of Ngchen shows a large expanse of rice fields, most of which are flooded much more deeply than is desirable. 20km south west of Muiluk. July 1932. (RLP Photo No. 144-4)



Fig. 286. Along the coast behind the sand dunes there is a considerable area of marsh land some of which has been converted into rice fields. This view along the road from Muiluk to Kwangchouwan shows one of these fields being plowed. In the extreme distance are sand dunes. 30km south west of Muiluk and south west of Ngchen (Unchien).

July 1932. (RLP Photo No. 144-10)





Fig. 287. Looking north west along the road toward Chekam, which is visible on the distant hill. At the right in the foreground is shown a section of weathered sedimentary deposits. About 2km south east of Chekam, Kwangchouwan. July 1932. (RLP Photo No. 145-2)



Fig. 288. This is a detail of the general section shown in No. 145-2. The profile shown here is as follows: iron concretions about 5cm; brown, slightly mottled reddish and whitish soil 5-200cm; more "shaley" material from 200-350<sup>+</sup>cm. This is on the roadside cut about 2km south east of Chekam, Kwangchouwan. July 1932. (RLP Photo No. 145-3)



Fig. 289. A small valley terraced for rice cultivation. Some of the fields are plowed, one being cultivated and some already have been planted out. In the distance and toward the right is a dyked stream coming from the uplands in the distance where the hills are very much eroded. About 2km south west of Chekam, Kwangchouwan, and not far from the localities shown in Nos. 145-1 to 145-3 inclusive. July 1932. (RLP Photo No. 145-4)



Fig. 290. This view is a detail of the erosion in the extreme distance of No. 145-4. This erosion has cut back into the deeply weathered sedimentary material. No iron concretions are visible. In the valley in the distance is a small field of sesamum to the left of which a number of boys may be seen. The uplands are unused. About 2km south west of Chekam, Wangchouwan. July 1932. (RLP Photo No.145-5)



Fig. 291. Another view of the erosion in the same locality as that shown in 145-5. The exposures show about one meter of reddish brown sandy loam underlain by about 2 meters of mottled reddish and whitish materials. There are some flakes or small platy iron concretions. About 2km south west of Chekam, Kwangchouwan. July 1932. (RLP Photo No. 145-6)



Fig. 292. Another eroded locality in the same uplands as No. 145-6, but about 3km south east of Chekam. On the distant wall of this ravine are exposed the harder iron cemented layers, as well as the softer material lying between. Below about 1 and a half meter's depth the subsoil material is mottled red and white. For a detail of this see No. 145-8. July 1932. (RLP Photo No. 145-7)



Fig. 293. This is a detail of the general exposure shown in No. 145-7, the portion shown being 3±m vertical distance. The profile is as follows: 50±cm sandy loam, 5±cm iron cemented quartz grains, 35±cm sandy loam, 10±cm iron cemented quartz grains, 50±cm splotched red and yellow coarse sandy loam. This horizon is the one in which the pick is. 10±cm of thin iron cemented material. Below this to the bottom of the view extends the light blue clay with some red spots. About 3km south east of Chekam, Kwangchouwan. July 1932. (RLP Photo No. 145-8)



Fig. 294. A garden patch of tungkua melons. On each side of the melon patch is a portable watchman's hut. Sugar cane in the distance. This is on the upland soil. 4±km south east of Chekam, Kwangchouwan. July 1932. (RLP Photo No. 145-10)



Fig. 295. Extensive erosion of the sedimentary deposits. 4±km south east of Kwangchouwan and not far from the cultivated land shown in 145-10. In the extreme distance at the left may be seen a portion of the bay. ESE of Chekam, Kwangchouwan. July 1932. (RLP Photo No. 145-11)





Fig. 296. Another extensively eroded ravine not far from the one shown in 145-11. In the lowland at the left is a small field of sesamum. The reddish brown sandy loam that is exposed in the soils of the ravine exhibits a slight columnar structure. In the underlying material neither bedding planes nor horizons are regular, indicating the shallow water nature of the original deposits. 3.5 km east-south-east of Chekam, Kwangchouwan. July 1932. (RLP Photo No. 145-12)



Fig. 297. The eroded region near that shown in 145-11, 12. The irregular nature of the deposits is visible here. Much quartz gravel and iron cemented hard-pan lie in the foreground. In the distance is the aggrading stream which carries away the material eroded from this locality. On the horizon is Chekam town, 3 km distant. July 1932. (RLP Photo No. 146-1)



Fig. 298. Another view of the ravine to the left to that shown in 146-1. There are some rice fields in the bottom of the valley which can still be cultivated, since the ditches have been built to lead the stream around the base of the eroded hills at the right. This erosion has gone so far that, like much of the rest of it, nothing can be easily done to control it or to remedy the situation. However, the small grove of trees on the distant hill shows that this upland will carry a good foresting if it has the chance. 3 km east-south-east of Chekam, Kwangchouwan. July 1932. (RLP Photo No. 146-2)



Fig. 299. Erosion so very frequently occurs along cart tracks or country roads. In the distance is a very deeply eroded road of this sort. Professor Hoffman is standing above the road at the left. 3½km east-south-east of Chekam, Kwangchouwan. July 1932. (RLP Photo No. 146-3)



Fig. 300. The eroded uplands are a little nearer the estuary. The desolate character of this erosion is apparent. The iron cemented hardpan is visible in places. 3½km east-south-east of Chekam, Kwangchouwan. July 1932. (RLP Photo No. 146-4)



Fig. 301. Even on the severely eroded material in the ravines, pines like to grow if they are planted and given a chance, as can be seen in this view. The uplands from which Nos. 146-3, 4 were taken are seen on the horizon. Chekam. July 1932. (RLP Photo No. 146-5)



Fig. 302. Broken coral and sea shells collected at lime kilns at Yungchin near the southern boundary of Kwangchouwan. 1 km south of Chekam. July 1932. (RLP Photo No. 146-8)



Fig. 303. The vast upland plain about 8km north west of Liuchou (Hoihong). The white heaps in the distance mark a soil depression where white clay is mixed for details of this deposit see Nos. 146-11, 12. July 1932.  
(RLP Photo No. 146-10)



Fig. 304. The surface soil at the kaolin pits shown in Nos. 146-10, 12. The soil here is darker than that on the upland plains. It is a dark gray to grayish brown sandy loam. About 8km north west of Liuchou (Hoihong).  
July 1932. (RLP Photo No. 146-11)





Fig. 305. A general view of one of the pits from which the kaolin has been excavated. The main deposits of this white material lay below the water level at the time this photograph was taken. The cause of the formation of this material was undoubtedly the local topography which caused the rain water of this region to accumulate in the depression and so produce intensified leaching. See also Nos. 146-10, 11. 8 km north west of Liuchou (Hoihong). July 1932. (RLP Photo No. 146-12)



Fig. 306. Intensive fields of matting rush occupying the lower lying soil in the valley. Where the water is apt to be very deep the rice does not do so well. In the distance across the valley is a good grove of trees marking a village. About 11 km north west of Liuchou, (Hoihong). July 1932. (RLP Photo No. 147-5)



Fig. 307. The main stream flowing through the valley shown in Nos. 147-4, 5 and 6. Due to the erosion on the valley slopes the stream carries a large amount of sediment and is very heavily dyked. Along the dyke in the foreground is a hedge of pandan. Along the dyke in the distance are groups of spiny bamboo. The continued accumulation in the bed of the stream necessitates the rapid increasing of the height of the dykes. About 11 km north west of Liuchou (Hoihong). July 1932. (RLP Photo No. 147-7)



Fig. 308. The commission crossed the valley shown in Nos. 147-5,6 and 7 and over the low eroded upland. This view is looking west across the second valley which is in the foreground. The distant slopes are considerably eroded. On the opposite slopes are some terraces and the valley bottom has a little rice. About 12km north west of Liuchou (Hoihong).

July 1932. (RLP Photo No.147-8)



Fig. 309. This is a ravine about 8 meters deep which has been cut by the water running down the slopes of the upland shown in the distance in No. 147-8. As the feet of the men there is exposed in the sides of the ravine 4 meters of reddish brown sandy loam, and below this 3 meters of yellow and brown mottled material. The lowest portion of the profile is 1 meter of light bluish clay with red splotches. The floor of the wash is of iron cemented plates. About 12km north west of Liuchou (Hoihong). July 1932. (RLP Photo No. 147-9)



Fig. 310. On the opposite or westerly side of the hill shown in No. 147-8,9. There is still marked extensive erosion. As is apparent here the erosion is cut down through the old cross-bedded sediments. In places these are iron cemented. For a scale note Mr. Pan who is standing above at the right. About 13km north west of Liuchou (Hoihong). July 1932.

(RLP Photo No. 147-10)





Fig. 311. The clearly shallow water cross-bedded nature of these upland deposits is shown in the ravine bank exposed here. This view is to the left of that shown in 147-10. About 13km north west of Liuchou (Hoihong). July 1932. (RLP Photo No. 147-11)



Fig. 312. This is a detail of the deeper material exposed in the ravine wall, a general view of which is shown in No. 147-11. In this detail are sands above, then bedded compacted clays and below more sands. The colors are purplish red above, yellow grays and light blue below. 13km north west of Luichou (Hoihong). July 1932. (RLP Photo No. 147-12)



1  
2  
3  
4  
5

Fig. 313. This is another detail of the same ravine as shown in Nos. 147-10, 11, and 12. The cross bedding and irregular nature of the shallow water deposits is quite obvious. The layers of irregular iron cemented material are conspicuous. In the cut they are marked "2" and "4". "1" indicates a yellowish material "3" purplish and "5" again yellowish. For a scale note the 40cm long pick below the middle. 13km north west of Luichou (Hoihong). July 1932. (RLP Photo No. 148-1)





Fig. 314. Looking across the third valley to the west of the main upland shown in Nos. 146-10 and 148-10,11 and to the west of the locality shown in Nos 147-10,11 and 12. The foreground is eroded and has very scant vegetation. In the valley there are some fields of rushes and beyond there are some of rice. In the extreme distance across the valley the hills are bare and eroded. At the left is quite a good growth of trees indicating what the upland soils will do when given a chance. About 13km north west of Luichou (Hoihong). July 1932.

(RLP Photo No. 148-2)



Fig. 315. A view looking east, in the opposite direction, across the same valley as shown in Nos. 147-8,9. Both the near and far slopes of the valley are badly eroded as is shown by the very deep ravine in the immediate foreground. The small valley floor in the distance is producing some irrigated rice. The slopes, although they have been terraced in places, they are at the present time practically uncultivated. About 12km north west of Luichou (Hoihong). July 1932. (RLP Photo No.148-3)



Fig. 316. A deep and wide gully near and to the left of the locality shown in No.147-1. For a scale note the figure, that of Mr.Pan, above and at the left on the horizon. This indicates that the ravine is about 10 meters deep. In the distance, at the upper end of the ravine, is a thick hedge of pandan and some other shrubs, which is useful to help hold the soil and divert the water running down into the ravine and so intensifying the wash. Such a hedge is also a protection against people or animals falling into the ravine. About 10km north west of Luichou, (Hoihong). July 1932. (RLP Photo No.148-6)



Fig. 317. Looking down the same ravine as the shown in No. 148-6. It should be noted that the horizons exposed in the bank are not parallel to the present surface slope of the land. They are doubtless the result of the original nature and form of deposition of the material, thus causing localization of such materials as the iron compounds which have caused the cementing of certain layers. 10km north west of Luichou (Hoihong). July 1932. (RLP Photo No. 148-7)



Fig. 318. Very deep red soil with an iron cemented layer far below the surface. Below this cemented layer is visible a whitish substratum. In the distance is the upland plain shown also in Nos. 148-10,11. About 9km north west of Luichou (Hoihong). July 1932. (RLP Photo No. 148-8)



Fig. 319. Another view of the ravine shown in No. 148-8, showing the very deep layer of red soil. The underlying material is yellowish, purplish and whitish. For a scale note Mr. Pan who is standing on the promontory at the right in the middle distance. 9km north west of Luichou (Hoihong).

July 1932.(RLP Photo No.148-9)





Fig. 320. The vast uncultivated reddish brown sandy loam upland plain, looking east along the road. It is said that years ago this entire plain was cultivated. Certainly the topography is favorable, but apparently the soils are relatively quite poor. About 8km north west of Luichou.

July 1932. (RLP Photo No. 148-10)



Fig. 321. Another view of the same plain as shown in No. 148-10, in this case looking to the south west in place of to the east. In the distance in the slight depression is shown the deserted village Tung Yung Mei marked by the small group of trees. This upland plain at the present time produces very little, but some sparse grass. Around a few villages the soil is cultivated and does produce upland crops such as sweet potatoes, cassava and peanuts. It could also produce a large amount of fuel and timber if trees were planted and protected. 9km north west of Luichou, (Hoihong). July 1932.

(RLP Photo No. 148-11)



Fig. 322. A very deep ravine eroded back into the reddish brown sandy loam near the aerodrome, about 3km west of Luichou. The soil shows a slight tendency to assume a columnar structure. The material exposed toward the bottom of the ravine is almost white. For a scale note Mr. Pan who is standing at the edge of the ravine. Luichou (Hoihong). July 1932.

(RLP Photo No. 148-12)





Fig. 323. Rice plains southeast of Luichou, as seen from the walls of Luichou town, located on the edge of the Pakhoi series of soils. July 1932. (RLP Photo No. 149-9)



Fig. 324. Irrigating with a water scoop on the recent alluvial soils southeast of Luichou. July 1932. (RLP Photo No. 150-3)



Fig. 325. A detail of the outside of a borrow pit showing an exposure about three-quarters of a meter. The subsoil has completely kaolinized. It is mottled purplish and red and light bluish gray. Iron oxide deposits running through this material indicate the cracks in the original rock before weathering. Nan Nung Village, about 7km south of Luichou (Hoihong). July 1932. (RLP Photo No. 150-9)



Fig. 326. Slopes of the upland reddish brown sandy loam, showing erosion of some of the slopes over which the road had run. Beyond are some upland fields and in the left distance a village indicated by the trees. In some of the valleys rice is grown and some of the uplands are cultivated, but as a whole the country is very unproductive. Obviously the soil is poor. About 10km west of south of Luichou (Hoihong). July 1932. (RLP Photo No. 150-10)



Fig. 327. Looking down a gentle slope toward a shallow valley, showing how seriously the reddish brown upland sandy loam erodes along the cart tracks of the "main road" down the Peninsula. About 12km south west of Luichou (Hoihong) July 1932. (RLP Photo No. 150-11)



Fig. 328. On the upland where the road commences to cross the extensive region of basaltic material. The soil in the foreground is a brownish red clay loam weathered from basalt. Looking back along the road toward the north east, the distant hill is of the upland reddish brown sandy loam which is shown in many views among which are numbers 148-10 and 150-10, 11. About 20km south west of Luichou (Hoihong). July 1932. (RLP Photo No. 150-12)



Fig. 329. A pineapple plantation on the reddish brown clay loam from basalt. It is notable that there are a number of plantations of this sort on the basaltic clay loam whereas none were seen on the less fertile sandy loam. About 20km south west of Luichou (Hoihong). July 1932. (RLP Photo No. 151-1)



Fig. 330. At the right a pineapple plantation interplanted with bamboo. The left foreground is uncultivated. In the far distance is a shallow valley with a growth of trees marking the location of a village. Beyond the village again are the bare upland hills. About 20km south west of Luichou (Hoihong). July 1932. (RLP Photo No. 151-2)



Fig. 331. The country between Pakka Village and Wushek, showing rice in the foreground and beyond are beans planted on banks about 3 meters wide. In the distance is a low scrub. This is typical of the basalt uplands in this part of the Peninsular. 5½km north of Wushek. July 1932. (RLP Photo No. 151-9)





Fig. 332. Truck gardens just east of Meicheng Village. On this reddish brown sandy loam soil with brownish red clay loam subsoil are grown beans, cassava, sesamum, indigo, cucurbits. About 20km west of Chumen. July 1932.

(RLP Photo No. 152-9)



Fig. 333. A sesamum field on reddish brown sandy loam. In the distance are fields of cane and millet. This view is looking north east from near Meicheng Village and is typical of the basaltic uplands of this region. 20±km west of Chumen. July 1932. (RLP Photo No.152-10)



Fig. 334. The uplands to the south east of Meicheng village. In the foreground the soil is fallow. Just beyond are squashes and some other truck. In the shallow valley are some rice fields. The soil in the foreground is reddish brown sandy loam. 20±km west of Chumen. July 1932.

(RLP Photo No. 152-11)



Fig. 335. A country cart road, eroded, about 3m deep, in the reddish brown sandy loam shown in Nos. 152-9,10,11. The profile exposed in the cart road is shown in No. 153-1. About 1 km east of Meicheng and 20±km west of Chumen.

July 1932. (RLP Photo No. 152-12)



Fig. 336. The soil profile exposed in the bank of the eroded road shown in 152-12. The profile is as follows: 0-25 ±cm cultivated grayish brown with numerous potsherds; 25-250 ±cm reddish brown to brownish red sandy loam, gradually changing with depth to a heavy sandy loam at the bottom. Numerous roots are found extending several meters deep. About 1 km east of Meicheng and 20km west of Chumen. Luichou Peninsula.

July 1932. (RLP Photo No. 153-1)



Fig. 337. A detail of a roadside cut in the weathered basalt material about 1½km south east of Meicheng, being located in the far distance of view No. 152-11. This detail shows secondary deposits around fragments of weathering basalt. There are also iron and other concretions. 20±km west of Chumen. Luichou Peninsula. July 1932. (RLP Photo No. 153-2)



Fig. 338. Concentric weathering of basalt exposed in a roadside erosion. This is close to where No. 153-2 was taken. The soil in the field above is a gravelly loam with iron concretions. The crops grown are cassava and Cajanus.  $1\frac{1}{2}$  km south east of Meicheng and 20km west of Chumen. Luichou Peninsula. July 1932. (RLP Photo No. 153-3)



Fig. 339. This view is looking back across the shallow valley shown in No. 152-11. Meicheng Village is just over the horizon. On the horizon are the localities shown in Nos. 152-9 - 12. In the foreground is a compost drying floor with a heap of compost not far away. About  $1\frac{1}{2}$  km south east of Meicheng and 20km west of Chumen. Luichou Peninsula.

July 1932 (RLP Photo No. 153-4)



Fig. 340. A wall of basaltic weathering boulders and some cemented concretionary masses, similar to what is found in lateritic subsoils. Over the stone wall may be seen a Jack fruit tree, a stone mill and a bamboo and mud hut. Meicheng Village, 20km west of Chumen. Luichou Peninsula. July 1932. (RLP Photo No. 153-5)





Fig. 341. Ruined walls and brush choked gardens are all that mark the site of a former village along the Meicheng - Chumen road. The soil in this region appears to be quite fertile, being a friable clay loam from basalt. It was obviously intensively cultivated at one time, but has now grown to jungle. Luichou Peninsula. July 1932.

(RLP Photo No. 153-6)



Fig. 342. The ruins of a stone roller sugar cane mill near the road between Chumen and Hoi An Hù Village. This is one of the many reminders of the amount of sugar cane that was milled in this region. About 2km south east of Chumen.

July 1932. (RLP Photo No. 153-9)



Fig. 343. A view more or less characteristic of the country along the road south east from Chumen to Hoi An Hù. The cultivation near the road is of moderate intensity. There is some indigo and rice. On the horizon amongst the scrub jungle are visible coconut palms. July 1932.

(RLP Photo No. 153-10)



Fig. 344. A peanut field on the dark greyish brown soil of this locality. Across the slight depression is visible the short second growth forest which is common over much of this region. Along the road between Chumen and Hoi An Hù. July 1932. (RLP Photo No. 153-11)



Fig. 345. Cemented iron concretions exposed in a dry stream bed about 2-3m below the general soil surface. In the background are some agave plants. Along the Chumen Hoi An Hù road. July 1932. (RLP Photo No. 153-12)



Fig. 346. Cemented iron concretions exposed in a slight roadside cut at Hoi An Hù. Beyond the buildings may be seen a bit of the harbor. On the horizon across the water is a second growth forest. This entire region is underlain by basalt and the soils are reddish brown to brown. Hoi An Hù. 15km south of Chumen. July 1932. (RLP Photo No. 154-1)



Fig. 347. A sea bluff cut into basalt facing Hainan Strait, about 1 km south west of Hoi An Hù. The beach at the foot of this bluff is composed of basaltic boulders and cobble stones. See No. 154-5,6 for details of this bluff. July 1932. (RLP Photo No. 154-3)



Fig. 349. A detail of the basaltic bluff, with the camera pointing upward. Immediately under the grass is about 1 m of brownish red clay loam. This is underlain by about 1 meter of cemented concretions. Below this is exposed about 2 meters of basalt. Conspicuous among the plants above and at the left side of the foreground are pandans. About 1 km south west of Hoi An Hù and 15km south of Chumen. July 1932. (RLP Photo No. 154-5)



Fig. 350. Weathering basalt exposed in a ravine which cuts back into the main sea bluff of basalt. The soil, some of which is shown above at the left, is a brownish red. Underlying that are a number of meters of deeply weathered basalt. The long line on the horizon is an extension of the same bluff of basalt around to the west of the Bay and several km distant from the camera. This site is near Nos. 154-3,4,5. 1±km SW of Hoi An Hù and 15km south of Chumen. July 1932. (RLP Photo No.154-6)





Fig. 351. Farming land looking north west from the north gate of Chumen town. The crops here are upland rice, cassava, corn, melons and beans. The road, marked mainly by a foot path, is the so-called main road north to Luichou. Chumen. July 1932. (RLP Photo No. 154-9)



Fig. 352. Looking north east from the north gate of Chumen. Near at hand are the cultivated fields planted to upland rice, cassava, corn, melons and beans. In the distance beyond, a km or two away, begins a low second growth forest that extends for many km. This view is to the right of that shown in No. 154-9. Environs of Chumen. July 1932. (RLP Photo No. 154-10)



Fig. 353. The ruined village of Hsa Chiao on the direct north road to Luichou, about 10 km northwest of Chumen. July 1932. (RLP Photo No. 155-5)



Fig. 354. The "road" north from Chumen to Luichou, being merely a trail cut through the low second growth forest. The soil in this entire region seems to be similar, heavy brownish red to red clay loam. About 15km north west of Chumen. July 1932. (RLP Photo No. 155-6)



Fig. 355. Compost heaps on a compost drying and mixing floor near Pakhoi on the upland sandy loam. The nearest heap is a mixture of the bluish gray sea mud and manure and other organic matter. Just beyond are two heaps of broken but unmixed mud. In the distance are other heaps of mixed material. See also Nos. 156-6, 157-2, 7. July 1932. (RLP Photo No. 156-4)



Fig. 356. A heap of mud from the tide flats of Pakhoi Bay. In the foreground is a long thin stone roller for breaking up mud after it has been dried. The mud is on a drying floor, but as the photograph was taken just after a shower, the floor is covered with water. In the distance may be seen the tide flats of the Bay, as it was the time of low tide. August 1932. (RLP Photo No. 156-6)



Fig. 357. Heaps of sea mud drying and leaching on the upper beach of Pakhoi Bay. This mud is hauled out by carts from the tide flats at times of very low tide and kept here for a time as it is needed for making compost. It is taken into the upland and used as shown in Nos. 156-4,6. The mud often contains a large quantity of shells as may be seen in No. 157-7. Near Kaoda Village, about 4km east of Pakhoi.

August 1932. (RLP Photo No. 157-2)



Fig. 358. Looking along the upper beach at the base of the bluffs showing the heaps of sea mud leaching and drying prior to being carried on the upland mixing floors. This mud is hauled out from the sea at very low tide. It is very variable in texture owing to the quantity and quality of sea shells which it contains. Near Kaoda Village, about 4km east of Pakhoi. August 1932. (RLP Photo No. 157-7)



Fig. 359. A portion of sea bluff showing at the top 2m of sandy loam and gravels underlain by 4m of red sandy clay with white splotches and at the base below the pick 75cm of light purplish sandy clay with white splotches. Kaoda Village about 4km east of Pakhoi. August 1932. (RLP Photo No. 157-10)





Fig. 360. A profile of the Pakhoi brown sandy loam exposed in a gully on the roadside above the sea bluff. From the surface down to the upper portion of the pick, or 30±cm the soil is a dark grayish brown sandy loam. From 30-140±cm the subsoil is a brownish red sandy loam somewhat heavier than the surface soil. At 140±cm, i.e. near the bottom of the exposure are visible some gravels. Kaoda Village, about 3½km east of Pakhoi. August 1932. (RLP Photo No. 157-12)



Fig. 361. A profile of Pakhoi sandy loam formation exposed in a roadside cut. The surface soil to 2±m in depth is reddish brown sandy loam, below which are 5±m of purplish and whitish mottled a clay. This station is near Kaoda Village and about ½km from the sea along the Pakhoi - Limchou road. August 1932. (RLP Photo No. 158-2)



Fig. 362. A profile of dark valley soil in the uplands. The surface soil down to 50±cm is black. From 50± -100±cm it is grey and reddish. Below about 1 meter the soil is bluish, white, red and pink mottled. For a scale note the pick on the soil surface. This soil occupies depressions originally poorly drained in the upland reddish brown sandy loam plains which has resulted in accumulation of organic matter and in the development of very light colored subsoil. Recently the erosion has increased causing excessive drainage. Along the Pakhoi - Limchou Road, about half way between the two towns. August 1932. (RLP Photo No. 158-4)



Fig. 363. A small plantation of relatively tall pine trees which have been severely trimmed up to furnish fuel. They are growing in the upland brown sandy loam, showing what tree growth the soil can produce. The distant valley is planted to rice, while the uplands as a whole are uncultivated. 17km north east of Pakhoi, along the Pakhoi - Limchou road, and about km south of Limchou. August 1932. (RLP Photo No. 158-5)



Fig. 364. A typical scene on the Pakhoi upland sandy loam soils occupied mainly by grass and some graves. The Pakhoi - Limchou road is visible at the right in the distance. Occasional clumps of thorny bamboo mark village sites. About 3km south of Limchou along the Pakhoi - Limchou road. August 1932. (RLP Photo No. 158-6)



Fig. 365. A small waterfall along a brook, the fall being caused by the harder semi-cemented layer underlying the brown sandy loam soil. A good deal of this surface soil has been eroded away along this brook. On the upland in the distance are a few graves, otherwise the land is quite unused. Along the Pakhoi-Limchou Road, about  $2\frac{1}{2}$ km south of Limchou. August 1932. (RLP Photo No. 158-7)



Fig. 366. Looking from the Pakhoi brown sandy loam soils out toward the rice fields on the river flood plain in the distance. This view is looking in the opposite direction from that shown in No. 158-7. Limchou town is on the horizon, about  $2\frac{1}{2}$ km distant. August 1932. (RLP Photo No. 158-8)



Fig. 367. A typical view of the Pakhoi brown sandy loam soil east of Pakhoi. These uplands are entirely uncultivated. In the depression there is a black soil underlain by white subsoil. This soil is at times planted to rice. On the horizon is a group of trees marking the location of the Lan Kong pawn shop. About 20km ENE of Pakhoi. August 1932. (RLP Photo No. 158-11)



Fig. 368. An opening in the young pine forests on the Pakhoi sandy loam uplands between Lan Kong and Ching Chu Shing. Professor Hoffman and a fish peddler in the middle distance. About 25km east of Pakhoi. August 1932. (RLP Photo No. 158-12)





Fig. 369. At the head of a deep ravine near Ching Chu Shing (Paklung). Below Mr. Pan are 2m of brownish red sandy loam. From 2 to 4m below the surface the subsoil is gravelly. From 4-5m below the surface the substratum is mottled white and purplish. For an illustration of this same ravine looking in the opposite direction see No. 159-8. About 1 km from Ching Chu Shing (Paklung) and 30km east of Pakhoi. August 1932. (RLP Photo No. 159-7)



Fig. 370. Looking down a ravine from the upper end. The biggest pine tree shown at the left is only about 18 meters from the head of the ravine, showing that this ravine is not eroding headward very rapidly for the pine is probably fifteen years old. This is in the upland sandy loam and is the same ravine, the head of which is shown in No. 159-7. In the distance may be seen the rice in the lowland and the distant hill of upland sandy loam. For a detail of the erosion of that locality see No. 159-9. About 1 km from Ching Chu Shing and 30km east of Pakhoi. August 1932. (RLP Photo No. 159-8)



Fig. 371. Erosion of the west side of the valley shown in Nos. 159-1 and 8. The surface soil is here almost entirely carried away leaving a light colored substratum material. The erosion was undoubtedly started and has been intensified by the washes along the old road. Our party and guard are visible along the trail at the right. About 2km north west of Ching Chu Shing and 29km east of Pakhoi. August 1932. (RLP Photo No. 159-9)



Fig. 372. Loads of pine needles being carried to the village for fuel. Beyond the carriers is a typical pine plantation. This is almost the only use for the brown Pakhoi sandy loams in this region. Between Lan Kong and Ching Chu Shing (Paklung). About 28km east of Pakhoi. August 1932.  
(RLP Photo No. 159-11)



Fig. 373. A pit for the excavation of clay for making pottery. The extremely distinct soil profile has been largely obscured by the wash of white clay down over the exposed face. "S" -20±cm of black soil spoil, "1" -18±cm of black soil in places with color largely obscured. "2" -80±cm of nearly black decomposed organic matter. "3" - white slightly sandy clay. This pit is located in the lower portion of a valley in the upland sandy loam. About 1 km south east of Lan Kong and 20km east of Pakhoi. August 1932.  
(RLP Photo No. 160-1)



Fig. 374. The flood at Limchou comes up to the city gates, flooding the western suburb toward the river. Flooded land is also visible in the distance beyond the river. August 1932.  
(RLP Photo No. 160-9)



Fig. 375. The flood at Limchou on the eastern side of the city comes up to the city wall and road, deeply flooding the lower land. August 1932. (RLP Photo No. 161-8)



Fig. 376. The sands west of Pakhoi, at Tikoa village. This is a fishing village, and the nets are spread on the sand to dry. August 1932. (RLP Photo No. 163-10)



Fig. 377. Pakhoi town from a low hill to the west near Tikoa Village. In the foreground is a greyish brown gravelly loam. Beyond are some sand dunes between which are lower soils planted to rice in what was previously a lagoon. On the horizon at the right are young pine plantations. August 1932. (RLP Photo No. 164-1)





Fig. 378. Rice, taro and sweet potato fields on lowland soils in the distance. This valley with its village lies between the gravelly loam hill in the foreground and the Pakhoi brown sandy loam on the horizon. This view is from the same station as that shown in No. 164-1 and lies about 2km south west of Pakhoi. August 1932. (RLP Photo No.164-2)



Fig. 379. The brown upland sandy loam with a slight valley in the distance and on the horizon some low hills. This view is looking south from a few km east of Limchou. In the valley are a few rice fields. About 8km north east of Limchou. August 1932. (RLP Photo No. 164-12)



Fig. 381. A view in the uplands  $\pm$ 20km east of Limchou along the main road to Kungkwang, with a sand stone hill covered with quartzitic gravelly loam in the foreground. In the valley beyond are ponds and rice fields. On the horizon are pines growing on the upland brown sandy loam. August 1932. (RLP Photo No. 165-2)



Fig. 382. A compost mixing floor showing heaps sifted and coarser material. In the foreground is a grass thatch protecting a heap. In the distance the man is raking together manure and soil. Beyond him is a heap of mixed ashes and soil. ~~For a detail of the tools used see No. 165-5.~~ About 300 chin of this compost are used per mou of transplanted rice. Less is used on the uplands. About 25km east of Limchou on the Kungkwang road. August 1932. (RLP Photo No. 165-4)



Fig. 383. Fertilizing a rice seed bed and removing the seedling sods for planting in the fields. The figure at the right is scattering sifted compost over the seedlings. The sods are then peeled off with about 2cm of the surface soil and are carried to the field where they are planted. This seed bed of about 2 x 12 meters to which about 300 chin of compost are applied is used to plant one mou of land. Each mou of rice land is fertilized with 100 chin of slaked lime to each of the two crops per year and also about 10 chin of lime are applied to a single seed bed as shown. One mou of rice in this locality should give about 1500 chin of paddy. About 27km east of Limchou on the Kungkwang road. August 1932. (RLP Photo No. 165-6)



Fig. 384. A detail of a transplanted rice field, showing black compost still around each group of seedlings. These were transplanted from the seedbed shown in No. 165-6. About 27km east of Limchou on the Kungkwang road. August 1932. (RLP Photo No. 165-7)



Fig. 385. Harvesting matting rush which is being dried on the lower slopes of the hill in the distance. In the foreground is some recently transplanted rice. About 40km east of Limchou. August 1932. (RLP Photo No. 165-10)



Fig. 386. A compost mixing floor with 2 heaps of burned sod. The man is carrying a load of grass balanced by a chunk of sod on a shovel. In the distance are rice fields. Looking in the opposite direction from No. 165-10.  $\pm$ 40km east of Limchou on the Kungkwang road. August 1932. (RLP Photo No. 165-11)



Fig. 387. Chali village with the big pawn shops conspicuous. The main Limchou - Kungkwang road is evident at the left. The fields are of recently transplanted rice.  $\pm$ 42km east of Limchou. August 1932. (RLP Photo No. 165-12)





Fig. 388. Where the distance between the rice field and the rice seed bed is too great to justify the carrying of the heavy sods, the rice seedlings are pulled out from the soil, tied in bunches and transplanted in the manner shown in this view. 45km east of Limchou on the Kungkwang road.

August 1932. (RLP Photo No. 166-2)



Fig. 389. A typical village on the slightly higher land at the base of the hill. In the foreground are rice beds on grayish brown silt loam. About the village are groups of bamboo while on the hill slopes the covering is very scanty composed mainly of small pines.  $\pm$ 45km east of Limchou on the Kungkwang road. August 1932. (RLP Photo No. 166-3)



Fig. 390. A tamped earth building under construction. The form is on the upper wall, at the right. The walls after tamping are chisled like concrete and then plastered with a hard lime plaster. Reinforced concrete is used for lintels and second story floors. Kungkwang, northeast of Pakhoi.

August 1932. (RLP Photo No. 166-9)



Fig. 391. Looking across a relatively narrow strip of cultivated land lying between the hill slope and the road in the foreground and the bare limestone rocks on the shore in the distance. The main crop shown in these fields is beans. The heavy tree growth in the left distance is a temple grove. About 38km north of east of Limchou on the Kung road.

August 1932. (RLP Photo No. 166-11)



Fig. 392. A stream cut in what seems to be moderately young alluvium of the main river valley. The stream in the foreground is a tributary which has exposed its bank by erosion. The profile is as follows: 20±cm of light grey over-wash. 30±cm of dark grey soil. 300±cm of yellowish brown material and 100±cm of bluish to light yellowish brown material. Just above the water's edge is a waste heap of material fallen from above. About 10km north east of Limchou on the Kungkwang road.

August 1932. (RLP Photo No. 167-2)



Fig. 393. A view showing the brown upland sandy loam and the old road in the foreground. In the distance is the river lowland with an occasional clump of trees marking the location of villages. About 20km east of north of Limchou on the Lihong road. August 1932. (RLP Photo No. 167-3)



Fig. 394. Looking down the river at Shekhong from the old fortifications on the edge of the uplands. The upland soil material here being a gravelly loam. Near Lihong just to the left of No. 167-5 which shows a portion of the town. About 20km east of north of Limchou. August 1932.

(RLP Photo No. 167-4)



Fig. 395. Looking north up the river at Shekhong. A portion of the town being visible at the right. In the foreground is some of the upland gravelly loam. About 20km east of north of Limchou. August 1932. (RLP Photo No. 167-5)



Fig. 396. Local cart with fertilizer cask, for transporting liquid night soil from town to fields. Shekhong. northeast of Limchou. August 1932. (RLP Photo No. 167-7)





Fig. 397. Shekhong town in the distance. At the right of the road are the same two fertilizer carts as shown in No. 167-8, about 20km east of north of Limchou. August 1932. (RLP Photo No. 167-9)



Fig. 398. A very narrow gully from 3 to 5 meters deep. This erosion originated by the water running down an old cart road. The soil is a brown gravelly loam with some quartzitic pebbles. Mr. Pan is at the head of the ravine on the horizon. This is near Nos. 167-8,9, East of Shekhong. About 20km east of north of Limchou. August 1932. (RLP Photo No. 167-10)



Fig. 399. Preparing compost for application to rice fields. Earth, ashes, pig and other manures and lime are being mixed together. This practice seems to be known locally. It is undoubtedly very bad to mix lime with the material because of the loss of ammonia which was apparent at the time. The local price of lime is 24 cash (2 coppers and 4 cash) per chin. About 20km east of north of Limchou. August 1932. (RLP Photo No. 167-11)



Fig. 400. The same compost heap shown in No. 167-11 a few minutes later. The mixing is completed, the heap formed and quickly covered by portable grass thatch as a precaution against an approaching thunder shower. Shekhong, about 20km east of north of Limchou. August 1932. (RLP Photo No.167-12)



Fig. 401. Erosion in the upland soils south of Shekhong. The exposure shows about 2 meters of stony loam underlain by about 4 meters of white material splotted with red. Apparently there are no concretions. The Shekhong bus station is visible in the distance beyond the thorny bamboo. About 20km east of north of Limchou. August 1932. (RLP Photo No.168-2)



Fig. 402. Brown sandy loam profile showing a medium dark brown to brown soil without any very obvious horizon differentiations. This profile is exposed in a roadside cut about 75 meters distant from No. 168-2. This profile is located at a higher elevation than No. 168-2 and is undoubtedly younger geologically than the other. Near Shekhong, about 20km east of north of Limchou. August 1932.  
(RLP Photo No. 168-3)



Fig. 403. An upland brown sandy loam looking in the opposite direction from the same station from which No. 168-5 was taken. In the distance is a small valley with some fields of rice, taro, sesamum and potatoes. Some pine are planted at the right and beyond in the extreme distance. About 15km north east of Limchou on the Shekhong road.

August 1932. (RLP Photo No. 168-4)



Fig. 404. The upland brown sandy loam south west of Shekhong. This view is looking south west, showing a vast expanse of uncultivated unused soil. Topographically it is very favorable for cultivation. About 15km north east of Limchou, on the Shekhong road. August 1932. (RLP Photo No. 168-5)



Fig. 405. The upland reddish brown sandy loam showing a profile of about 3 meters exposed in a roadside borrow pit. The pick is nearer the camera and marks a heap of iron concretions. About 2km west of Hoihow, Hainan Island.

August 1932. (RLP Photo No. 171-2)





Fig. 406. The upland brownish red sandy loam exposed in a road cut near the top of the bluff. The dark streak is a freshly exposed soil surface made at the time of taking the photograph. There is no evident development of horizons in the three meters exposed. About 2km west of Hoihow, Hainan Island. August 1932. (RLP Photo No. 171-3)



Fig. 407. A road cut bank about six meters high showing the following profile: 1±m of brown sandy loam or gravelly sandy loam. From 2± - 6±m a light yellowish brown sandy loam and gravelly loam. In places there is a great deal of quartz ~~sand~~ sand. To the left of the pick in the upper part of the photograph is an older harder surface. This view was taken on the edge of the bluff and just below the point from which Nos. 171-5, 6 were taken. About 8km west of Hoihow, Hainan Island. August 1932. (RLP Photo No. 171-4)



Fig. 408. Looking north east from the edge of the older upland. In the distance at the left are rice fields and beyond them sand dunes along the beach. On these sands are some lime kilns. On the distant bluff at the right is an old fort. This view was taken from just above the side of Fig. 407. About 8km west of Hoihow, Hainan Island. August 1932. (RLP Photo No. 171-5)



Fig. 409. In the foreground is a solid cemented iron concretionary horizon. In the valley beyond are rice fields. The distant uplands are soils of the Pakhoi series. This view is in the opposite direction from Fig. 408. August 1932. (RLP Photo No. 171-6)



Fig. 410. A "rock" of sponge-like concretionary material in which is included much quartz, cemented sand and gravel. This iron cemented material is somewhat like hardpan found in the subsoils in lateritic soils. This view is only a few meters distant from Figs. 407, 408 about 8km west of Hoihow. Hainan Island. August 1932. (RLP Photo No. 171-7)



Fig. 411. An exposure of sandy material and cemented portions of the substratum underlying the upland Pakhoi series soils. Above the cemented layer is a slope covered with small concretions obscuring a clay horizon of bluish color splotched with red. This view is in a locality where there is very much erosion. Other views in the same locality are Figs. 412, 413. About 11km west of Hoihow, Hainan Island. August 1932 (RLP Photo No. 171-8)





Fig. 412. An extensive erosion of the unconsolidated sedimentary upland material showing in the foreground concretionary fragments as well as quartz sand and gravel. For a scale note the men and cattle in the distance at the right. Above on the horizon may be seen junks on the Hoihow Bay. This view is in the same locality as Nos. 171-8, 10. About 11 km west of Hoihow, Hainan Island. August 1932. (RLP Photo No. 171-9)



Fig. 413. The eroded sedimentary upland region along the north coast of Hainan Island. In the foreground is the light greyish brown Pakhoi series coarse sandy loam. The old terraces here are not cultivated now, probably because of the poverty of the soil. On the far hill at the right are also old uncultivated terraces. In the valley bottom are rice fields. Beyond them may be seen the serious erosion occurring in these soils. On the horizon toward the right may be discerned the tops of two hills, said to be volcanoes. About 12km west of Hoihow, Hainan Island. August 1932. (RLP Photo No. 171-10)



Fig. 414. Stone walls, cultivated fields and a distant village in the basalt region. The basalt lies to the west of the sedimentary upland deposit shown in Nos. 171-2 to 5, and 8 to 10 inclusive. The topography is rougher and in spite of the large number of stones the brown loam soil is intensively cultivated. See also No. 171-12. About 14km west of Hoihow, Hainan Island. August 1932. (RLP Photo No. 171-11)





Fig. 415. The intensively cultivated brown loam soil Chumen series residual from basalt. This view is looking down the slope so that it does not show the large number of stones which form the terrace walls. The crops here are sweet potatoes with some sugar cane beyond. In the extreme distance across the depression is visible the upland brown sandy loam from sedimentary material as is shown in Nos. 171-2 - 10 and 172-1, 2. This view was taken from the same point as No. 171-11. About 14km west of Hoihow, Hainan Island. August 1932. (RLP Photo No. 171-12)



Fig. 416. The soil profile exposed in a roadside borrow pit showing the sedimentary material of the Pakhoi series loam. The profile details are as follows; 0-30±cm cultivated soil (sandy loam); 30-60±cm reddish brown (sandy loam); 60-70±cm a layer of iron concretions; from 70±cm to the bottom of the cut a gravelly loam becoming coarser and lighter in texture, gradually through a pink mottled to reddish brown and white. For a scale note the pick, the handle of which is about 40cm long. For a detail of the upper portion of a nearby exposure see No. 172-2. About 11 km west of Hoihow, Hainan Island. August 1932. (RLP Photo No. 172-1)



Fig. 417. A road section across a former cultivation terrace, showing concretionary horizon "K" lying parallel to the original soil surface. On the terrace slope a pick may be seen. The crop on the field above is sweet potato at the time the picture was taken. About 11 km west of Hoihow. August 1932. (RLP Photo No. 172-2)



Fig. 418. Uncultivated fields in the foreground and some low hills. In the distance are rice fields. The light brown soil is seemingly not very fertile. On the distant hill are pine trees. Taken from the train north of Kong Cheung Station, about 20km north of Canton. August 1932. (RLP Photo No. 172-3)



Fig. 419. Rice fields with a little hemp in the foreground and pines in the distance at the left. Taken from the train about 30km north of Canton. August 1932. (RLP Photo No. 172-4)



Fig. 420. Rice fields, a village, a group of trees near Quen Tien Station. The soil is a light yellowish grey to light brownish grey, almost white below. Taken from the train, about 40km north of Canton. August 1932. (RLP Photo No. 172-5)



Fig. 421. A hill slope planted with some pines but eroding very badly. The soil is apparently residual from granite. The fields in the foreground are idle. Taken from the train about 50km north of Canton. August 1932. (RLP Photo No.172-6)



Fig. 422. A hill slope with a relatively good covering of small pines and fuel ferns as well as a few small Cunninghamia trees. The erosion from other hills nearby has resulted in the fields in the foreground being covered and rendered useless by an overwash from a stream. Taken from the train between Ngan Chan An and Ying Chiu Stations. About 57km north of Canton. August 1932. (RLP Photo No. 172-7)



Fig. 423. Rather irregular rice fields on the valley floor. On the distant hill are terraces planted to sugar cane. The soil where visible is apparently from granites and is a light yellowish brown to light greyish brown. Taken from the train south of Yuen Tam Station. About 65km north of Canton.

August 1932. (RLP Photo No. 172-8)





Fig. 425. A relatively very fertile portion of the main river valley. Only a very small portion of the fields shown are irrigated and those are in the foreground. Beyond are hemp and other crops being raised without irrigation. Still further is a grove of bamboo marking the location of a village. The high distant hills are covered only by grass. Taken from the train about 90km north of Canton. August 1932. (RLP Photo No. 172-10)



Fig. 426. The North River with Limkonghou on the western bank. Taken from the train about 104km north of Canton. August 1932. (RLP Photo No. 172-11)



Fig. 427. The Limkong were it empties into the North River, near Limkonghou station. Hilly region, with no alluvial land. Taken from the train, about 104km north of Canton. August 1932. (RLP Photo No. 172-12)



Fig. 429. A limestone bluff showing a rock quarry where there is exposed the light brown soil very irregular in depth. Taken from the train about 130km north of Canton. August 1932. (RLP Photo No. 173-2)



Fig. 430. Upland unirrigated crops such as millet, peanuts, sesamum, sweet potato and some sugar cane, on the river flood plain. The hills are limestone and as a whole quite steep. Taken from the train about 140 km north of Canton. August 1932. (RLP Photo No. 173-3)



Fig. 431. River valley with rice fields on all the land that can be irrigated. The unirrigated portion is at the left in the middle distance and the hills beyond are uncultivated. The two groves of trees are growing around temples. Taken from the train about 150km north of Canton. August 1932. (RLP Photo No. 173-4)



Fig. 432. Women applying lime to the fields of young transplanted rice. The lime is scattered broadcast and then stirred into the soil with the feet. At the base of the distant slightly wooded hills is a small village. Taken from the train about 160km north of Canton. August 1932. (RLP Photo No. 173-5)



Fig. 433. A cultivated valley about 1 km south west of Maba station. The fields are partly in rice and partly in other crops. Beyond the village at the base of the hill is a plantation of pine trees, conspicuous in contrast with the rest of the hills which are grassy. Taken from the train about 163km north of Canton. August 1932. (RLP Photo No. 173-7)



Fig. 434. Rice fields on the wider portion of the plain. The hills are lower, but as a whole are not utilized. Taken from the train near Maba station, about 163km north of Canton. August 1932. (RLP Photo No. 173-8)





Fig. 435. A relatively very broad valley but with much of the area not cultivated. On the lower portion rice is planted. This locality offers an excellent opportunity for the raising of forest products. Taken from the train about 183km north of Canton. August 1932. (RLP Photo No. 173-9)



Fig. 436. Riverwash of sands and gravels along the western shore of eastern fork of the North River at Shiuchou. August 1932. (RLP Photo No. 173-10)



Fig. 437. Along the road north west from Shuikwan. The soil is a light brown silt loam and in places a fine sandy loam. On the limestone hill at the right the soil is much eroded. The distant hill is almost entirely covered only by grass. About 2km north west of Shiuchou. August 1932. (RLP Photo No. 174-3)



Fig. 438. A recently excavated deep railway cut in extensively weathered shales and fine sandstones. The surface soil is brown and only about 25cm deep. At the base of the cut there are some purplish streaks in the deeply weathered material. About 3km north west of Shiuchou. August 1932. (RLP Photo No. 174-4)



Fig. 439. Looking across sugar cane fields toward the west fork of the river. Some of the distant hills have pine on them but most of them carry only grass. About 4km north-west of Shiuchou. August 1932. (RLP Photo No. 174-5)



Fig. 440. Looking down a broad small valley showing a few rice fields some of which have been limed and are ready to have straw worked into the surface ~~soil~~ soil. There are some sugar cane fields beyond. The cultivation here is not intense. About 6 km north west of Shiuchou.. August 1932. (RLP Photo No. 174-7)



Fig. 441. A recently exposed soil profile in a railway cut showing a very slight horizon differentiation. The soil is brown to reddish brown, quite heavy and moderately finely granular. The pick marks a deeper and irregular rock horizon. About 7km north west of Shiuchou. August 1932. (RLP Photo No. 174-8)



Fig. 441-A. Lowland rice with bunches of straw in the water ready to be treading into the mud. The low uncultivated slopes and hills toward the left are of sedimentary material, probably "red-beds". About 8km north west of Shiuchou. August 1932. (RLP Photo No. 174-9)



Fig. 442. A weathered or rather old exposure showing the slightly columnar structure of the soil on the roadside. The soil at the surface is a brown light clay loam, gradually becoming a reddish brown clay loam at the bottom of the exposure which is about  $1\frac{1}{2}$ m below the surface. About 9km north west of Shiuchou. August 1932. (RLP Photo No. 174-10)





Fig. 443. A road cut showing an exposure of about  $2\frac{1}{2}$  meters. The soil is a purplish red clay loam, grading into a clay with depth. At the bottom of the exposure may be seen a layer of gravels. About 10km north west of Shiuchou. August 1932. (RLP Photo No. 174-11)



Fig. 444. Low hills, almost entirely uncultivated except for the few fields of rice in the bottom of the valley. The rice straw has been saved and is presumably to be used in the rice fields. This is in the same locality as Nos. 174-11, 175-1, 2. About 10km north west of Shiuchou. August 1932. (RLP Photo No. 174-12)



Fig. 445. Looking from the low hills across the rice and sugar cane fields to the river. Beyond the river are some low hills with pine, but most of the higher hills are covered with grass only. This was taken from the same place as No. 174-12 and 175-2. About 10km north west of Shiuchou. August 1932. (RLP Photo No. 175-1)



Fig. 446. Looking north west up the river and road from the same point as that from which Nos. 174-12 and 175-1 were taken. The near hills are of purplish red soil, probably from "red-beds" material. In the distance are some rice fields. About 10km north west of Shiuchou. August 1932.  
(RLP Photo No. 175-2)



Fig. 447. Farmers treading rice straw of the first crop into the mud between the recently transplanted rice. This operation is carried out after lime has been broadcast over the entire field and it is done only for the second planting. The first crop of the year does not receive any such application of straw, though the first crop is usually limed. The soil of this field is a clay loam and of the typical bluish gray color. About 11 km north west of Shiuchou. August 1932.  
(RLP Photo No. 175-3)



Fig. 448. A recently exposed deep soil profile along the railway cut leading from the river back to a coal mine. Workmen are trimming up the bank. The soil as exposed is about 20cm of brownish grey underlain by about 3 to 6 meters of brown (clay loam?). The deeper material is only partially weathered rock and may be distinguished in the photograph by the lighter color. About 13km north west of Shiuchou. August 1932. (RLP Photo No. 175-4)



Fig. 449. Looking south-west up the West Fork of the river from the hill near Liputao. At the curve of the river a number of boats may be seen being towed up. On the plain are a great many fields planted to sugar cane. Along the river banks are clumps of bamboo. Most of the hills carry only a covering of grass. From this same station were taken Nos. 176-2,3 and 4. Liputao, about 19km north west of Shiuchou. August 1932. (RLP Photo No. 176-1)



Fig. 450. Looking north west over the plain and low hills lying beyond Liputao. Coming from the right and going into the centre distance is the grade of the new railway extension toward Hankow. At the extreme left is a portion of the highway to Lokchong. This view is taken from the same station is Nos. 176-1,3,4. August 1932. Liputao, about 19km north west of Shiuchou. August 1932. (RLP Photo No. 176-2)



Fig. 451. Looking north across the new railway grade and the low hills and rolling grass lands. There is almost no cultivated land visible. The railway cut shows reddish brown soil of the upper slopes. While in the hollows the soil is whitish. This view is from the same station as Nos. 176-1,2 and 4. The site is near Liputao, about 19km north west of Shiuchou. August 1932. (RLP Photo No. 176-3)





Fig. 452. Looking south east down the river from the hill top near Liputao. At the base of the hill is visible the pine grove shown in No. 175-12. Coming from the right beyond the hill is the highway, and the railway grade is visible beyond the pine grove, coming from the left. Near the railway and the road are fields of peanuts and beans. Beyond the river most of the fields are of sugar cane. This site is near Liputao, about 19km north west of Shiuchou, August 1932. (RLP Photo No.176-4)



Fig. 453. Red beds and red bed material on the north bank of the west fork of the North River, Northwest of Shiuchou. Erosion and recent railway cuttings have exposed the deeper material. August 1932. (RLP Photo No. 176-9)



Fig. 454. Erosion in a grassy slope at the base of the hill toward the river. These hills might all well be planted to trees not only to supply fuel and timber but also to prevent such erosion as this from continuing. The erosion is not only damaging the soil of the hills but is also seriously injuring the otherwise good soils in the various valleys at the base of the hills. About 5km north west of Shiuchou. August 1932. (RLP Photo No. 176-10)



Fig. 455. Yellowish brown soil on a hill which is at least in part limestone. Northwest of Shiuchou, along the river.  
August 1932. (RLP Photo No.176-12)



Fig. 456. Looking southward down the narrow river flood plain of the East Fork of North River. The soils here are brownish grey and relatively medium in texture. They are planted to peanuts, beans and other upland crops. Shiuchou pagoda is at the left. The river and house boat colony are in the centre. The trees at the right indicate the location of the German mission compound. About 1 km north of the railroad station of Shiuchou. August 1932. (RLP Photo No. 177-4)



Fig. 457. Residual and narrow valley bottom soils from red beds material. The buildings in the foreground and the road below are a part of the coal mine development in this locality. The distant hills have a yellowish brown soil, indicating other than a red beds origin. The fields in the valleys are planted to the second crop of rice. This view is looking to the South east and from the same station from which Nos. 177-6,7,8 were taken. About 4km east of Shiuchou. August 1932.  
(RLP Photo No. 177-5)



Fig. 459. The cultivated lower valley slopes and grassy hill sides. Taken from the same site from which Nos. 177-5,8 were taken. Most of the fields are planted to the second crop of rice, though in a few cases there are mushroom beds and some truck gardens. The soils of the hills in the distance are yellowish brown. The mountain slopes in places have been extensively dug over in search of coal. About 4km east of Shiuchou.

August 1932. (RLP Photo No. 177-7)



Fig. 460. Looking westward from the same site from which Nos. 177-5,7 were taken. In the rice fields, which occupy most of the valley floor, straw is being treading into the mud. There are a few fields of vegetables at the right. The soils of the distant grassy hills are light yellowish brown. In the further distance they appear to be redder in color. The station from which this photograph was taken is about 4km east of Shiuchou. August 1932.

(RLP Photo No. 177-8)



Fig. 461. A small valley with rice fields in the bottom and pines on the red bed soils on the hill beyond. At the time this picture was taken straw was being treading into the soil of these fields. The further hill shows distinct evidence of some efforts at afforestation for it was quite apparent that there had recently been extensive plantings on the upper slopes. About 3km east of Shiuchou, along the coal mine road. August 1932. (RLP Photo No. 177-9)





Fig. 462. A soil profile exposed along the road to the coal mine, showing a brownish to light yellowish brown clay loam. Below the pick visible at the right the subsoil is mottled. On the slope above is a grave. About 3km east of Shiuchou. August 1932. (RLP Photo No. 177-10)



Fig. 463. A farmer and his family treading rice straw into the field of second crop rice. This farmer says that straw applied in this way makes the soil softer the following year. He also usually applies lime to both crops of rice every year using up to 200 chin per mou per crop. The cost is about \$1 a picul plus 70 cents for carrying. These fields yield  $2\frac{1}{2}$  piculs per mou per crop. The soil in the foreground is a purplish red. About 3km east of Shiuchou on the coal mine road. August 1932. (RLP Photo No. 177-11)



Fig. 464. A road bank profile of light brown to light yellowish brown soil which is common in this region. The surface soil is a silt loam from 40 to 60 cm deep, underlain by a light clay loam subsoil. The cover of the hill is of pine, Cunninghamia, grass and ferns. Along the coal mine road, about 3km east of Shiuchou. August 1932. (RLP Photo No. 178-1)



Fig. 465. Looking west down the East Fork of North River, showing the very narrow alluvial plain and the hills on both sides of the river, from the same site where Nos. 178-3, 4 were taken. About 10km north east of Shiuchou on the Namyung road. August 1932. (RLP Photo No. 178-2)



Fig. 466. Looking north west across the East Fork of North River showing fields of upland crops on the terraces beyond the river. The near hills of red beds material carry a relatively good covering of trees. For views to the left and right of this see Nos. 178-2 and 178-4. About 10km north east of Shiuchou, along the Namyung road. August 1932. (RLP Photo No. 178-3)



Fig. 467. Looking north up the east fork of North River, showing the relatively small amount of agricultural land on the lower slopes of the hills. As usual most of the hill slopes are almost bare of trees, carrying nothing but grass. For views to the left of this see Nos. 178-2,3. About 10km north east of Shiuchou and on the Namyung Road. August 1932. (RLP Photo No. 178-4)



Fig. 468. A valley along the main north east highway with slightly reddish grey to grey clay loam soils. The rice crop in this locality is distinctly poor. The bare hills in the distance are of red beds material. About 18km north east of Shiuchou, along the Namyung road. August 1932. (RLP Photo No. 178-5)



Fig. 469. In some localities the rice straw from the first crop is burnt in the fields or along the edges of the fields as is the case in this view. There seems to be no consistency in the farmers' practice regarding the disposal of the straw. About 14 km north east of Shiuchou on the Namyung road. August 1932. (RLP Photo No. 178-7)



Fig. 470. The fields which during the earlier part of the year were planted to rice are here shown formed into low patches planted to sweet potatoes as the second crop of the season. The hills in the distance have only a very few trees on them, the main covering being grass. About 22km north east of Shiuchou on the Namyung road. August 1932. (RLP Photo No. 178-9)





Fig. 472. The rocky bluffs along the east fork of the North River, on the Namhung Road, where the new road is being constructed above the river. August 1932. (RLP Photo No. 179-6)



Fig. 473. Looking up the east fork of the North River, from near the station from which Fig. 472 was taken. The narrow alluvial plain between the river and the low hills to the east is visible. August 1932. (RLP Photo No. 179-7)



Fig. 474. The riverwash between the town and the river at Konghou, near Chihing, about 50 km northeast of Shiuchou. August 1932. (RLP Photo No. 179-8)



Fig. 475. At the extreme northeasterly limit of our trip toward Namyung, we were in the valley shown here, where taro, peanuts, sweet potatoes and rice are grown extensively. However, the cultivation is less intensive as might be judged from this view. Near Kong Hou, about 50km east of north east of Shiuchou, on the Namyung Road. August 1932. (RLP Photo No. 179-11)



Fig. 476. Another view of the small intensively cultivated valley in which the rice field dykes or field boundaries are planted to beans. Behind the buildings in the distance the hill slope may be observed as quite well terraced with young trees. About 28km north east of Shiuchou on the Namyung road. August 1932. (RLP Photo No. 180-9)



Fig. 477. A limestone bluff near Maba Station, taken from the train, about 10km south of Shiuchou and about 177km north of Canton. August 1932. (RLP Photo No. 181-1)



Fig. 478. The broader valley south of Shiuchou, where there is in the rice fields some reddish brown soil that is used for irrigated rice. August 1932. (RLP Photo No. 181-2)



Fig. 481. The rather open river valley just north of Wushek station. The old "highway" bridge crosses the stream near the railway. August 1932. (RLP Photo No. 181-5)



Fig. 482. A light brown alluvial soil planted to rice and other crops just south of Wushek station. Taken from the train. About 25km south of Shiuchou and about 164km north of Canton. August 1932. (RLP Photo No. 181-6)





Fig. 483. Rice fields lying along the North River which is visible in the distance. Beyond the river is a considerable forest. North of Tai Han Hou Station, taken from the train. About 27km south of Shiuchou and about 162 north of Canton. August 1932. (RLP Photo No. 181-7)



Fig. 486. A small temple grove on a hill surrounded by rice fields showing what the otherwise largely unused soils will produce in the line of timber and fuel if they are protected. South of Sha Hou Station, taken from the train, About 41 km south of Shiuchou and 147km north of Canton. August 1932. (RLP Photo No. 181-10)



Fig. 487. The river flood plain of light brown to brown soils. These soils lie from 10 to 15 meters above the present river level. The river is visible in the distance. Taken from the train, north of Ho Tsu Station. About 63km south of Shiu-chou and 128 north of Canton. August 1932. (RLP Photo No.181-11)



Fig. 488. Looking south down the river across the river flood plain which is here intensively cultivated. Taken from the train just south of Hou Tan Station. About 62km south of Shiuchou and 127km north of Canton. August 1932. (RLP Photo No. 181-12)



Fig. 489. Rice fields most of which have had the first crop harvested and the fields plowed. In some cases the second crop has already been set out. In the field in the centre are shown heaps of partly burnt rice straw scattered about in the stubble of the first crop. In the distance is a large grove of bamboo, which seems to be planted extensively in this locality. Taken from the train south of Yin Tak. About 77 km south of Shiuchou and 113km north of Canton. August 1932. (RLP Photo No. 182-1)



Fig. 490. The broader river valley south of Yin Tak. Here the rice stubble of the first crop is still occupying most of the fields. In the distance is a large planting of bamboo. Taken from the train about 78km south of Shiuchou and 111 km north of Canton. August 1932. (RLP Photo No. 182-2)



Fig. 493. The western bank of the river valley which here is extremely narrow. On the nearest slope above the river just in the foreground are an old irrigation ditch and abandoned terraces. Below the old tow path the vegetation of the shrubs is very much heavier, possibly due to being less subject to burning by grass fires. South of Yin Tak Station, taken from the train about 79km south of Shiuchou and 107km north of Canton. August 1932. (RLP Photo No. 182-5)



Fig. 494. Mouth of the Lin River where it flows into North River. Bamboo and other forests occupy the hill slopes. Going up the North River is a typical power river boat. Taken from the train just north of Lin Kong Hou. About 85km south of Shiuchou and 105 north of Canton. August 1932. (RLP Photo No.182-6)



Fig. 497. The river valley and a distant village east of the railway at Par Kong Hou, south of Yin Tak Station. The soil is alluvial and light brown in color. Taken from the train. About 86km north of Canton and 195km south of Shiuchou. August 1932. (RLP Photo No.182-9)





Fig. 498. A narrower portion of the valley with rice fields in the foreground. To the left of the village there is ~~on-a~~ ~~small-hill~~ a large fish pond. The hills beyond the village are only sparsely wooded. The soils where exposed on the terraces are quite red. Taken from the train about 76km north of Canton and 116km south of Shiuchou. August 1932.

(RLP Photo No. 182-10)



Fig. 499. A higher lying portion of the valley with only a very little lowland rice. The lighter colored field is planted to truck, while beyond and at the right are a number of sugar cane fields. Higher on the slopes of the distant hill are smaller crops. Taken from the train About 64km north of Canton and 133 south of Shiuchou. August 1932. (RLP Photo No. 183-1)



Fig. 500. Very seriously eroded hills lying just beyond these rice fields. The subsoil where exposed is quite red. The soils of this hill are now quite ruined and it will be very difficult to establish any kind of a forest covering on them, while if such is not done and the erosion continues, the rice fields will certainly be damaged by the material washed off from these hills. Taken from the train. About 63km north of Canton and 134 south of Shiuchou. August 1932. (RLP Photo No. 183-2)



Fig. 501. Erosion along the stream bank in a tributary valley to the North River. There is fairly good forest cover just beyond the cattle, but as a whole the hills in this region are not carrying the forest cover that they should. Taken from the train. About 59km north of Canton and about 138km south of Shiuchou. August 1932. (RLP Photo No. 183-4)



Fig. 502. A small village along a stream. Behind the village are a few good sized pine trees, but as a whole the tree cover of the hills is quite sparse. Taken from the train north of Nganchanau Station. About 57 km north of Canton and 147 south of Shiuchou. August 1932. (RLP Photo No. 183-5)



Fig. 503. The rice fields in this view are being seriously endangered by the stream at the right. The bed of this stream is being continually raised by the accumulation of sand from the eroding hills further up the valley. Taken from the train. About 52km north of Canton and 145 km south of Shiuchou.

August 1932. (RLP Photo No. 183-6)



Fig. 504. More hills with poor or entirely lacking forest cover. Here again the rice fields at the foot of the slopes are certainly endangered by the soil material which is washed from the eroding hills above. Taken from the train about 50km north of Canton and 147 km south of Shiuchou. August 1932.

(RLP Photo No. 183-7)



Fig. 505. The hill shown here is eroding along the slope toward the right. The hills as a whole carry a very poor growth of young trees, evidently because they have not been given a fair chance to grow. The stream which lies between the rice fields and the hill has had its bed filled and is still further being raised by accumulations of sand from similar eroding places. Taken from the train. About 45km north of Canton and 151 km south of Shiuchou.

August 1932. (RLP Photo No. 183-8)



Fig. 506. The broader rice producing plain east of Lok Ting Station. The old country path or "road" here crosses through the fields. Taken from the train. About 33km north of Canton.

August 1932. (RLP Photo No. 183-10)





Fig. 507. Rice fields which at the time of taking the photograph were obviously well irrigated, occupy this plain. Sometimes during the year, however, the crops here are irrigated from shallow wells by the use of well sweeps, a large number of which may be seen in the left distance. Taken from the train, north of Suikai Station. About 31 km north of Canton. August 1932.

(RLP Photo No. 183-11)



Fig. 508. Another locality where numerous well sweeps indicate that at some other season of the year the crops are irrigated quite generally from shallow wells. Most of the fields shown were planted to rice at this time. In the right distance is one small field of hemp. Taken from the train north of Suikai Station. About 30 km north of Canton. August 1932.

(RLP Photo No. 183-12)



Fig. 509. Eroded hills west of the West Lake. Waichou town in the distance. The hill at the right shows landslide topography. In the valley bottom are rice fields. About 1 km west of Waichou. August 1932. (RLP Photo No. 184-4)



Fig. 510. A narrow valley west of Waichou town, which is in the distance. This valley shows rice in the bottom and terraces on the slope at the right. On the opposite slope is a ditch to divert the wash from the eroding hillside out beyond the rice fields area to prevent injury to the soils by overwash. The hills toward the pagoda are thickly covered by graves. West Lake beyond the pagoda. In the fore ground are gravelly and stony loams. About 1 km west of Waichou. August 1932.

(RLP Photo No. 184-5)



Fig. 511. Looking north east from a hill top about 1 km west of Waichou, showing particularly a hill slope which is eroding very badly. On the lower slope are a few terraces. The most of the land is quite useless and is also endangering the rice fields below. In the far distance beyond the trees is East River. August 1932. (RLP Photo No. 184-6)



Fig. 512. A small valley to the south west of Waichou, about 1½ km distant. Most of the hill slopes are covered only by grass where they should be carrying trees. In the distance and in the lower portion of the valley are rice fields and a village. For greater detail of this valley see No. 184-9. August 1932.

(RLP Photo No. 184-7)



Fig. 513. Waichou City from the hills west of West Lake. These hills are occupied very largely by graves which, according to local custom, precludes their use for Forestry. At the edge of the lake are a few rice fields. August 1932

(RLP Photo No. 184-8)



Fig. 514. A small valley about  $1\frac{1}{2}$  km south west of Waichou, showing the irrigation reservoir and fish pond at the upper end of the valley, below which are rice fields and villages. (This view is a detail of the valley shown in No. 184-7).

August 1932. (RLP Photo No. 184-9)



Fig. 515. Uncultivated fields and some terraced hill slopes near Maon village, about 10 km south east of Waichou. The soil here is a clay loam. Although the hill slopes have some trees they are not effectively used. August 1932. (RLP Photo No. 185-1)





Fig. 516. The bus station and local wheelbarrows at Maon, about 10km south east of Waichou. The low nearly bare hills and lack of intensity of agriculture are characteristic of the region. August 1932. (RLP Photo No. 185-2)



Fig. 517. Rice terraces on gently sloping land east of Maon, about 10 km east-south-east of Waichou. August 1932. (RLP Photo No. 185-3)



Fig. 518. A stream bank exposing a light greyish brown fine sandy loam alluvial soil, about 24km east-south-east of Waichou. The fields in the middle distance are planted to sweet potatoes and beyond are fields of sugar cane. August 1932. (RLP Photo No. 185-4)



Fig. 519. Alluvial soil along the same stream shown in No. 185-4. The hill at the left is of reddish soil which is eroding quite badly. At the right the lower hill has been cultivated nearly to the top by terracing. Near Wutang town, about 24km east-south-east of Waichou. August 1932. (RLP Photo No. 185-5)



Fig. 520. A farmer preparing compost by mixing and breaking up the soils and manure. At the left beyond is a thatched cover with which the heap is protected against the rain. The large tree beyond is a Ficus which is very good for shade but relatively of no value for timber or fuel. Other trees are of much more economical value for afforestation. Pingshan. August 1932. (RLP Photo No. 185-7)



Fig. 521. A stream valley and mountains about 6km east of south of Peingshan and 39km wouth east of Waichou. In this locality transportation is not so satisfactory and the land is less intensively utilized. (See No. 185-9). August 1932. (RLP Photo No. 185-8)



Fig. 522. A rice plain amongst the hills, about 6km east of south of Pingshan and about 39km south east of Waichou. In the foreground is a stream and a lower stream terrace. The hills beyond carry a very poor cover of trees. For a view to the right of this see No. 185-9. August 1932.

(RLP Photo No. 185-9)



Fig. 523. Pickshan village and in the foreground the main "road" to Swatow. At the right are rice fields and beyond the village is quite a good grove of trees, supplying both timber and fuel. The mountains beyond, however, are covered only with grass and thus are relatively of slight economic value. About 14km east of south of Pingshan. 45km south east of Waichou.

August 1932. (RLP Photo No. 185-10)



Fig. 524. Nimshan valley at the Yamping bus terminus. The valley floor is occupied by rice fields. The hill and mountain slopes are covered only by short coarse grass whereas these slopes could produce a large amount of timber and fuel. Nimshan on Bias Bay, about 20km east of South of Pingshan about 50km south east of Waichou. August 1932.

(RLP Photo No. 185-11)





Fig. 525. This rice fields has just had spread over it slaked lime which the women are mixing with their feet into the mud soil. While doing this they steady themselves with a long staff. The dosage of lime is from 20 to 40 chin per mou. It is obtained from burning sea-shells. Nimshan on Bias Bay, about 50km south east of Waichou. August 1932. (RLP Photo No. 185-12)



Fig. 526. Very serious erosion about 30 meters deep cutting down through hills and old terraces, since abandoned. The slopes below are also uncultivated at the present time. An adequate forest cover on these hills would have yielded a profit to the villagers in place of making the hills a liability through overwash of this material onto the lower lying lands of the valley. Nimshan, about 50km south of Waichou on Bias Bay. August 1932. (RLP Photo No. 186-1)



Fig. 527. The steep grassy peak is the same as shown in No. 185-11. It is surrounded by lower slopes which are eroding quite badly because of the lack of even suitable grass cover. On the nearer and fairly gentle slopes there are grass and graves and in the valley bottom a few small rice fields. Such country as this offers very great possibilities for afforestation. Nimshan. About 50km south east of Waichou. August 1932. (RLP Photo No. 186-2)



Fig. 528. Looking north west from a low hill, showing in the foreground an eroded slope, and in the distance beyond the rice fields on the plain is Nimshan town. This view is taken from the same point from which No 186-2 was taken. Nimshan valley about 50km south east of Waichou. August 1932. (RLP Photo No. 186-3)



Fig. 529. A portion of Nimshan valley. A village and rice fields at the edge of Bias Bay which is in the distance. In the foreground is an eroding spot on the otherwise grass and grave covered hill. This view was taken from the same site as No. 186-2,3. About 50m south east of Waichou. August 1932 (RLP Photo No. 186-4)



Fig. 530. Extensive areas of uncultivated or at best very poorly cultivated land north west of Pingshan. The soil is apparently of moderate fertility. The populace are said to have been driven away by bandits and the land has neer since been cultivated very well. In such cases as this the problem of exterminating the weeds is a difficult one. About 29km south east of Waichou. August 1932. (RLP Photo No. 186-6)



Fig. 531. Old previously cultivated terraces now all infested with Imperata grass and entirely uncultivated. The fertility is probably fair but depopulation due to lack of safety has left the land idle. In such places as this a suitable leguminous crop ought to be effective in obtaining a return and eliminating the weeds. About 28km south east of Waichou. August 1932. (RLP Photo No. 186-7)

of fertility



Fig. 532. Grass and weed grown fields and terraces. Eroding hills in the distance; along the Pingshan road, about 28km southeast of Waichou. August 1932. (RLP Photo No. 186-8)



Fig. 533. A serious erosion of hills along the main highway. About 25km south east of Waichou. Nos. 186-10, 11 also show this same locality from about the same point. The hills are of residual soil material extremely deeply weathered from granites. The soil seems to be so poor that it will not support even a protecting cover of grass to retard erosion. This view is looking southeast. August 1932. (RLP Photo No. 186-9)





Fig. 534. An eroded hill slope of material deeply weathered from granites. The lowland at the right lies idle because it has been covered by an unfertile overwash from the hills at the left. Beyond in the distance further from the hills are fields of sugar cane and peanuts. This view is looking north east. Nos. 186-9, 11 were taken from the same point. About 25km south east of Waichou. August 1932. (RLP Photo No. 186-10)



Fig. 535. The main south-east highway from Waichou passing through a road cut in the strongly weathered granites, illustrating the serious degree to which the material erodes and the lack of vegetation on the slopes. This view was taken from the same point as Nos. 186,9 and 10. August 1932. (RLP Photo No. 186-11)



Fig. 536. This view illustrates the serious nature of the erosion that occurs where a drainage ditch falls over a bank without adequate protection and the bank is very seriously eroded. The profile exposed shows the nature of the material underlying the rice fields: about 40cm of yellowish grey soil; from 40 to 50 cm is a transition zone; and below 50cm the subsoil is white with red splotches. In the distance is the Ching Kong bus station where the road to Tamshui branches off from the main Waichou-Cheungmukto road. About 18km south west of Waichou. August 1932. (RLP Photo No. 186-12)



Fig. 537. The Waichou--Tamshui road as it enters Chanlung town, going south toward the pass thru the mountains. About 18 km southwest of Waichou. August 1932. (RLP Photo No. 187-1)



Fig. 538. This view is of a narrow valley above Chanlung, showing brush and small trees on the slopes and a few rice fields in the valley bottom. These mountain slopes are quite suitable for forests and they should be carrying much more than they now have. About 22 km south west of Waichou and south west of Tamshui. August 1932. (RLP Photo No. 187-2)



Fig. 539. Looking southward from the pass in the opposite direction from near the locality shown in No. 187-2. The region is quite hilly with very shallow soils, though in the distance are some low terraces planted to rice. The new road to Tamshui is visible at the right. About 15km north west of Tamshui. August 1932. (RLP Photo No. 187-3)



Fig. 540. A soil profile of material residual on the so-called "red beds". The soil is very shallow and has no great importance. About 1 km south of the bus station of Tamshui and about 35km south of Waichou August 1932. (RLP Photo No.187-4)



Fig. 541. Looking eastward from the Tamshui - Outoukong road from a place about 1 km south of Tamshui. On the road are some salt carriers and beyond are rice fields. Aside from a few trees on the low hill at the left, the mountains are almost devoid of trees. The opportunities for afforestation are enormous. About 35km south of Waichou. August 1932. (RLP Photo No. 187-5)



Fig. 542. Lowland rice fields on a grey sandy loam overlying "red beds". In the distance are clumps of trees marking sites of villages. Looking north west across the Outoukong - Tamshui road. A few km south of Tamshui and about 39km south of Waichou. August 1932. (RLP Photo No. 187-6)





Fig. 543. Low hills in the region of slightly consolidated sedimentary or "red bed" deposits. In the foreground is a grey sandy loam. In the valley bottom are a few small fields of peanuts and rice. The distant valley slopes are badly eroded exposing deeply weathered white and red streaked material. The far hills are grassy and offer great scope for afforestation. About 7km south east of Tamshui along the Tamshui - Outoukong Road. August 1932. (RLP Photo No.187-7)



Fig. 544. A gravelly loam hilltop in the foreground with a few stunted pines. On the hill beyond is also a pine plantation, while at the left beyond the road are fields of rice. This view was taken from nearly the same point as No. 187-7, but looking in the opposite direction. Along the Tamshui - Outoukong Road, about 7 km south of Tamshui. August 1932. (RLP Photo No. 187-8)



Fig. 545. The road from Tamshui toward Outoukong where it passes down the narrow stream valley. Between the road and the stream are a few patches of rice and upland crops. Beyond the road are deeply weathered rocks. About 8m south east of Tamshui. August 1932. (RLP Photo No. 187-9)



Fig. 546. Salt marsh shrubs near Simouton village, shown in the distance. Beyond at the left are a few terraces on the hill slope with rock outcrop above. This salt marsh is the result of sea water invasion up the small valley near Outoukong. About 10km south east of Tamshui. August 1932. (RLP Photo No. 187-10)



Fig. 547. The Outoukong fort and a bit of the town with the road and bus station below and between. In the foreground at the left is a heap of compost protected by a matting from the rain. Just beyond and to the right is another heap exposed to the sunshine. Outoukong, about 12km south east of Tamshui, at the head of Bias Bay. August 1932. (RLP Photo No. 187-11)



Fig. 548. Terraces planted to peanuts at Outoukong, looking, ~~looking~~ in the opposite direction from the view shown in No. 188-1. On the hills beyond are numerous graves and grave jars. Aside from a few pines the hills are mostly grass covered. This port is a convenient shipping point for Hongkong and it would be an excellent place for the raising and shipping of timber and fuel. Outoukong, about 12km south west of Tamshui. August 1932. (RLP Photo No. 188-2)



Fig. 549. Sugar cane on a light greyish brown fine sandy loam alluvial soil about 1 km north of Tamshui and 31 km south of Waichou. The hill in the distance is the one from the top of which Nos. 188-7 to 12 were taken. August 1932. (RLP Photo No. 188-4)



Fig. 550. The old stonepaved country road passing through the rice fields about 1 km north of Tamshui. At the base of the hill is a small village with some shade trees and an orchard. The hill beyond is the one from which Nos. 188-7 to 12 were taken. August 1932. (RLP Photo No. 188-5)



Fig. 551. A pear orchard of light brownish grey gravelly loam at the base of the hill shown in Nos. 188-4, 5. On the terraces at the left are sweet potatoes planted under the pear trees. About 2km north of Tamshui and 30km south of Waichou. August 1932. (RLP Photo No. 188-6)





Fig. 552. A view of part of the Tamshui valley from near the top of the hill shown in Nos. 188-4,5. This view is looking north-westerly, showing sugar cane and sweet potatoes on the terraces near the foot of the hill. Beyond is a large farm house with rice fields around. In the distance are a succession of low hills and valleys, the hills being covered with upland crops and the valleys planted to rice. In the foreground are visible some of the young pine trees growing on the hill slopes. August 1932. About 2km north of Tamshui. (RLP Photo No. 188-7)



Fig. 553. Looking west from the hill top shown in Nos. 188-4,5. In the foreground are a few small pine trees on the hill slope. Between the foot of the hill and the village are rice fields. Below is the slightly rolling land planted to sugar cane, sweet potato and similar upland crops. The Tamshui valley from a point about 2km north of Tamshui. August 1932. (RLP Photo No. 188-8)



Fig. 554. Looking south east across the meandering river below Tamshui town. Amongst the foot hills nearby are fields of peanuts, sweet potatoes and sugar cane. Beyond the orchards is the alluvial plain with upland crops. From the same point from which Nos. 188-8,10,11,12 were taken. August 1932.

(RLP Photo No. 188-9)



Fig. 555. Looking eastward from the hilltop shown in Nos. 188-4,5. Between the foot hills in the foreground and the bare hill in the distance is the river with its flood plain. The long narrow fields on each side of the river are planted to peanuts and sweet potatoes. Nearer on the lower slopes of the hill are some rice fields and abandoned terraces. About 2km north of Tamshui and 30km south of Waichou. August 1932. (RLP Photo No. 188-10)



Fig. 556. Looking southwest from the hilltop shown in Nos. 188-4,5 and to the right of the view shown in No. 188-12. The Tamshui valley, as shown here, is a succession of lowland rice fields, and slightly higher soils planted to upland crops such as peanuts, sweet potatoes and sugar cane; and here and there trees in groups, marking the sites of villages. About 2km north of Tamshui and 30km south of Waichou. August 1932. (RLP Photo No. 188-11)



Fig. 557. Looking southward from the hill top shown in Nos. 188-4,5. At the foot of the hill in the foreground are a few orchards. Beyond are rice fields and still further a village and some cane and other upland crops. In the distance beyond the river is Tamshui town, about 2km away. August 1932. (RLP Photo No. 188-12)



Fig. 558. Rice and beans on reddish brown sandy loam in a shallow valley about 7km west of Tamshui on the Lungkong road. About 35km south of Waichou. August 1932. (RLP Photo No.189.7)



Fig. 559. A profile of the soil underlying the rice fields in the neighborhood of No. 189-7. There are about 40 cm of brownish grey soil; about 40-50 cm of dark grey; about 50-65cm grey streaked with red; from about 65 downwards white with reddish portions somewhat harder than the white. As distinctly shown, the material is somewhat columnar in structure. About 9km west of Tamshui on the Lungkong road. August 1932. (RLP Photo No. 189-8)



Fig. 560. A profile of the soil under the upland crops of poor peanuts and good beans: 0-20±cm dark brown loam, below 20±cm is a red clay. Across the valley in the distance are eroded grassy hills which should be planted to trees. About 10km west of Tamshui on the Lungkong road. August 1932. (RLP Photo No. 189-9)





Fig. 562. Some small rice fields, trees and distant terraces at Hangchi Village. About 10km west of Tamshui toward Lungkong. August 1932. (RLP Photo No. 189-12)



Fig. 563. Looking east from the low pass on the Tamshui - Lungkong road. Some scattering plantations of young pine are rather notable because of their limited area. Of these hills most could well be producing fuel and timber. The auto "road" is here still only a foot path. About 15km west of Tamshui and 6km east of Lungkong. August 1932. (RLP Photo No. 190-1)



Fig. 565. A building of tamped earth and lime under construction at Lungkong. The floors, pillars and lintels are of reinforced concrete. The main body of the building is of a gravelly clay subsoil plus lime. Lungkong 41 km west of south of Waichou. August 1932. (RLP Photo No. 190-5)



Fig. 567. Looking south west over the Lungkong plain. The lower hill slopes in places are terraced and in some other cases carry a few small pine, in place of considerable forests which ought to be here. On the plain are a number of villages and a meandering stream. Most of the valley is planted to rice. Taken from the hill top shown in No. 190-12. About  $1\frac{1}{2}$  km south of Lungkong and 42 km west of south of Waichou. For other views from this same point see No 190-8-11. August 1932. (RLP Photo No. 190-7)



Fig. 568. Looking north west from the hilltop shown in No. 190-12. On the Lungkong plain many large white houses, and some village tree groups are visible. Along the winding stream in the middle distance are lighter soils planted to cane and peanuts. Nearer and beyond the stream the plains are planted to rice where the soils are heavier. August 1932. (RLP Photo No. 190-8)



Fig. 569. Lungkong town, looking north from the hilltop shown in No. 190-12. The hill in the foreground is a reddish brown gravelly loam. Beyond the group of trees at the foot of the hillside are rice fields. About 42 km west of south of Waichou. August 1932. (RLP Photo No. 190-9)



Fig. 570. Looking north east from the hilltop shown in No. 190-12. In the small valley toward the foot of the hill in the foreground is rice and beyond on the plain are some rice fields and also a good deal of sugar cane. The upper portion of Lungkong valley, about 42km west of south of Waichou. August 1932. (RLP Photo No. 190-10)



Fig. 571. Lungkong town from a lower and nearer point than that from which No. 190-9 was taken. In the foreground is a gravelly sandy loam. On the slopes lower down are fields of sweet potatoes, taro and cane. Rice occupies most of the land on toward the town. August 1932. (RLP Photo No. 190-11)



Fig. 572. The hill about  $1\frac{1}{2}$ km south of Lungkong from which the views shown in Nos. 190-7 - 11 were taken. In the foreground are rice fields. August 1932. (RLP Photo No. 190-12)





Fig. 573. Hills and terraced slopes of brown sandy loam. The terraces are planted to peanuts, sweet potatoes, with rice, reeds and taro lower down. About 5km south west of Lungkong on the Pingwu road. August 1932. (RLP Photo No. 191-1)



Fig. 574. Looking down the same valley from the same place as that from which No. 191-1 was taken, showing fields of upland and in the distance some lowland crops. The hills beyond carry a fair growth of young pine. About 5km south west of Lungkong on the Pingwu road. August 1932. (RLP Photo No. 191-2)



Fig. 575. Grassy hills practically unutilized. Beyond is a pond, with some pines on the distant hill. The soil in this locality is quite variable, ranging from a gravelly loam to a clay loam. This locality is being considered as a possible site for fruit orchards. Pears and similar fruits should do quite well here. About 5km south west of Lungkong on the Pingwu road. August 1932. (RLP Photo No. 191-3)



Fig. 576. Looking in the opposite direction from the same station as that from which No. 191-3 was taken. These gentle slopes should prove quite satisfactory for fruit orchards and the steeper slopes in the distance could well be planted to forest trees for fuel or timber. About 5km south west of Lungkong on the Pingwu road. August 1932. (RLP Photo No.191-4)



Fig. 577. Rice and sugar cane on the lower valley slopes with some small pine in the foreground and on the distant hill. This view shows clearly the extreme degree to which the pines are trimmed up to supply branches for fuel. About 5km south west of Lungkong on the Pingwu road. August 1932. (RLP Photo No. 191-5)



Fig. 578. A lateritic "boulder" exposed in a road cut. The mass of concretions lies just below the soil pick. The parent rock is here apparently mildly metamorphosed sedimentary material. About 5km south west of Lungkong on the Pingwu road. August 1932. (RLP Photo No.191-6)



Fig. 579. Hills and more gently sloping valleys through which passes the Lungkong-Pingwu road seen in the middle distance. Aside from a few pines on the distant hill this country is producing very little. The upper slopes could well be afforested and the lower slopes near the road should grow good fruit. About 7km south west of Lungkong on the Pingwu road. August 1932. (RLP Photo No. 191-8)



Fig. 580. Looking south from the same point as that shown in No. 191-8. In the valley are some fields of rice and sugar cane. On the distant hill are a few small pines. About 7km south west of Lungkong on the Pingwu road. August 1932. (RLP Photo No. 191-9)



Fig. 581. This site is situated about one kilometer south of Cheong Muk Tou. The steep hillslope planted to fruit and pineapples, with some pines on the horizon. There is one Canarium tree, a number of lichi, pears, young guavas, etc. further up. In the foreground is some rice. August 1932. (RLP Photo No. 191-11)





Fig. 582. A detail of the terraces on the steeply sloping hill shown in 191-11. The terraces are not well made and are eroding quite seriously. In this view are shown pears, young guavas, lichi and pineapples. About 1 km south of Cheong Muk Tou. August 1932. (RLP Photo No. 191-12)



Fig. 583. Another view of the steeply sloping hill shown in No. 191-11,12. This slope is very badly eroded and the pineapples are suffering. In the distance are some lichi trees and on the horizon some pines. Such slopes as these should never be cultivated unless carefully terraced because the soil quickly washes away and leaves nothing but useless barren slopes which are not only unproductive, but mean damage to the low lying fields by overwash of material from above. About 1 km south of Cheong Muk Tou. August 1932. (RLP Photo No. 192-1)



Fig. 584. Looking south east across the valley from the seriously eroded hill shown in Nos.191-11,12 and 192-1. Some of the small pineapples are visible in the foreground. In the valley are rice fields and some sugar cane and truck above at the left. The village is quite compact and has more than the usual amount of forest of the slopes above. About 1 km south of Cheong Muk Tou. August 1932. (RLP Photo No. 192-2)



Fig. 585. Rice fields in narrow valleys between slopes planted to trees. On the hill between two valleys is a pear orchard. The railway passing up the valley is the main line from Kowloon to Canton. In the foreground is an orchard with pineapples and persimmons. This view is in the opposite direction from the one shown in No. 191-11. About 1 km south of Cheung Muk Tou. August 1932. (RLP Photo No. 192-3)



Fig. 586. Cheung Muk Tou station town, to the left of the view shown in No. 192-3. On the lower slopes of the hill in the foreground are pears and other fruit and rice fields beyond. About 1 km south of Cheung Muk Tou station. August 1932. (RLP Photo No. 192-4)



Fig. 587. Looking up the river valley in the opposite direction from that shown in No. 192-4 and to the right of that shown in 192-2. In the foreground is the seriously eroding side of the hill top, in the distance: river and some towns. Along the river are fields planted to sugar cane. The station from which this view was taken is the hilltop shown in No 191-11 and is about 1 km south of Cheung Muk Tou. August 1932. (RLP Photo No. 192-5)





Fig. 588. Individual circular terraces for lichee trees along the lower slope of a young pine plantation. Such terraces as these have some very distinct advantages for they are not so apt to erode as long contour terraces. About 1 km south of Cheung Muk Tou. August 1932. (RLP Photo No. 192-6)



Fig. 589. Lichee trees on broad level terraces. Coarse grass marks the edge of the terrace at the left. Beyond the tree at the right are sweet potato beds. About 1 km south of Cheung Muk Tou. August 1932. (RLP Photo No. 192-7)



Fig. 590. Truck gardens on broad terraces. This is a detail of the general view shown in No. 192-4 and lies near the town. This view is looking south west from a point about  $\frac{1}{2}$  km south of Cheung Muk Tou. August 1932. (RLP Photo No. 192-9)





Fig. 591. Fertilizing rice with lime and ashes. The building at the left is the same one as shown at the right in No. 192-10. About  $\frac{1}{2}$ km south of Cheung Muk Tou Station. August 1932. (RLP Photo No.192-11)



Fig. 592. An exposure about 4m high of very deeply weathered "red beds" material. The surface soil is brownish above. Deeper down are remains of purplish and brownish rock. This profile is a fresh road cut at Cheung Muk Tou railway station. August 1932. (RLP Photo No.192-12)



Fig. 593. The profile of the soil exposed in the excavations for the water works on the Lingnan University Campus, Canton. This soil is mapped Canton sandy loam, and shows below the surface reddish brown to brown sandy loam, the more red underlying material, with white streaks and splotches. A deeply weathered lixivium soil in which the nature of the parent material has been entirely changed. May 1931. (RLP Photo No. 1--6)



Fig. 594. Another profile of soil exposed in the excavations for the water works on the Lingnan University Campus, Canton. In this case there has been more disturbance of the surface soil than shown in that in the profile on the opposite side of the same excavation, as shown in Fig. 593. The white streaks and markings seem to be related to the structure of the parent material, tho all further resemblance has disappeared in the weathering process.

May 1931. (RLP Photo No. 1--7)



Fig. 595. Weathered granite, with some relatively sound boulders still remaining in a matrix of weathered material. A quarry face, with serious soil erosion above. Shaukiwan, Hong Kong. May 1931. (RLP Photo No. 2--3)



Fig. 596. A recent highway cutting thru weathered and some relatively fresh granite to a depth of about 40 meters. Taiku, Hong Kong. May 1931. (RLP Photo No. 2--4)



Fig. 597. A deep cutting thru weathered granites on the main highway near Taiku. Hong Kong. It is evident that the weathering has followed the jointing planes. Contrast this with Fig. 596 where the jointing is more conspicuously horizontal. May 1931. (RLP Photo No. 2--5)



Fig. 598. Very deep weathering of granites along the Shaukiwan road, near Taiku. Exposure in a recent highway cutting. Above are portions of old fortifications with the subterranean chambers. Hong Kong. May 1931. (RLP Photo No.2--8)



Fig. 599. Another view of the same cutting shown in Fig. 598, with the old fortifications above, and the soil erosion on the steep hill at the left above and beyond. Along the Shaukiwan road near Taiku, Hong Kong. May 1931.  
(RLP Photo No. 2--9)